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A SYSTEMATIC REGIONAL GEOGRAPHY

A POST-MATRICULATION COURSE

VOLUME I

THE BRITISH ISLES

BY

J. F. UNSTEAD, M.A., D.Sc.

**FORMERLY PROFESSOR OF GEOGRAPHY IN THE
UNIVERSITY OF LONDON**

**WITH NUMEROUS MAPS AND
DIAGRAMS SPECIALLY PREPARED
AND OTHER ILLUSTRATIONS**

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P R E F A C E

THE aim of this series is to provide a general course in Regional Geography, suitable for students following "Higher School," "Training College," or "Intermediate University" courses, which will not only give facts but will also provide a training in dealing with them, e.g. by explaining their significance and showing their correlations.

For over a century, geographers have been faced with the problem of the method of geographical science; the attempts made here at a partial solution are put forward by the writer in the hope that, having proved useful to him, they may be of service to others and in some small degree contribute to further advance.

The method adopted is based upon that outlined in the Herbertson Memorial Lecture delivered by the writer under the title: "A System of Regional Geography."¹ Its essential features are: first, Geography is conceived as the study of areas of the earth's surface in their entirety, i.e. as entities whose characteristics are determined by the interaction of all their living and non-living components; second, the study of the smallest regions or unit-areas is regarded as the basis of the work, which then proceeds by combining these into larger and larger areas, regions of higher orders, until the major regions of the world are reached.

Such an arrangement of regions is an aid in reducing the very great complexity of the subject-matter of Geography to a comprehensible and manageable system. It does, however, involve a number of difficulties; these are considered as they arise in connexion with particular areas, and attempts are made to find solutions.

In accordance with this scheme, South-eastern England is dealt with in some detail, affording opportunity for studying various types of region on a relatively large scale; and as the work extends over the rest of the British Isles, Europe and the remaining continents, the larger regions are necessarily treated as the units and in a more general manner, but with constant reference to their essential complexity.

¹ Published in *Geography*, Autumn 1933.

The method of dealing with each region may perhaps be labelled as "explanatory description"; instead of an invariable sequence of structure, relief, climate, river-systems, vegetation, people, industries, etc., the characteristics of each area are introduced in such a way that a description of the region is given and at the same time the causal relations between the component factors are shown.

As the characters of the regions differ, so the emphasis shifts, e.g. in some areas the structure is carefully studied, in others the climate needs special consideration, while elsewhere the human geography (though always regarded) provides the focus of attention.

The course is arranged in four volumes: Volume I deals with the British Isles, and introduces fundamental ideas and as thorough a study of relatively small areas as is possible in a general course; Volume II deals with the continent of Europe, and its subject-matter gives opportunity for considering the relation of physical conditions to political problems; Volume III deals with the world as a whole: the broad pattern of the major regions is shown; these regions are arranged in types, those of each type are compared and contrasted, and the characteristics, occupations, and ways of life of their inhabitants are studied in relation to their particular environments; finally, the interactions between the peoples of the world are explained, and the resultant social, economic, and political problems are examined.

To survey all parts and to consider all aspects of the world, however broadly, needs stringent selection of facts and regrettable limitation in showing causal relations; in a general work of this kind it is as impossible to avoid half-truths as to include the whole truth. The writer is very conscious of this difficulty, and will be grateful if readers will point out passages which may convey a wrong impression or include positive error. He is also conscious that with more detailed knowledge, the regional units and their groupings adopted in these books might be considerably improved; discussions of their validity and of amendments may indeed be a useful element in a geographical training.

The maps are intended to supplement, but not to duplicate those found in atlases which are indispensable to a student of Geography; hence the text refers to easily accessible maps showing relief, climate, vegetation, etc., while others, e.g. of

structure and soils, and of the regional divisions here adopted, have been specially drawn for this book.

The writer gratefully acknowledges his indebtedness to the authors of the books named in Appendix II, and particularly to the contributors to "Great Britain : Essays in Regional Geography," edited by Professor Ogilvie. He also expresses his gratitude to Professor C. B. Fawcett, who read the typescript of the greater part of the book, and to Dr. H. A. Matthews and Mr. E. J. Orford, who read the draft of the first chapters, for valuable suggestions; and to Mr. G. J. Cons for help in the preparation of the index.

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CORRIGENDA

Page 90, Table. The "New Red" deposits are partly Triassic and partly Permian in age.

Page 152, line 36. For "usually" read "unusually."

Page 198, line 17. For "Mountain Limestone" read "Carboniferous Limestone."

Page 217, Figure 50. The igneous rocks of the Ochill and Pentland Hills should be shown as lavas in the lower Old Red Sandstone, and the igneous rocks bordering the Firth of Forth as basalt above the Carboniferous Limestone.

Page 280, Table. For "Formations" at head of table read "Time Sequence of Strata referred to in the Text"; the "New Red" should be partly Triassic and partly Permian; the Permian should be included in the Palæozoic; for "Mountain Limestone" read "Carboniferous Limestone."

CHAPTER I

THE SOUTH DOWNS

IT is of practical importance for students of Geography to realize the essential character of their subject, and for this purpose it is useful to consider the question "What is Geography?" Certain sciences have an unmistakable subject-matter, e.g. Geology studies the nature and history of the earth's crust, Botany the plants which live upon it, and Anthropology the races of man and their characteristics; but the question arises whether Geography, dealing with the surface of the earth and all its plant and animal life (including man), has any definite subject-matter of its own. Can it be considered an independent science, or does it consist only of parts of the other sciences which investigate the various matters included by the geographer in his survey?

The view taken here is that Geography has indeed a subject-matter peculiar to itself, for the surface of the earth, the atmosphere, the plants, animals and man do not, in nature, exist separately but in inseparable combination. As an illustration a small area of the earth's surface may be considered; its position is of primary importance, determining the main features of its climate and affecting many other factors; the bed-rock of which it is composed influences its altitude and surface-form; these characteristics affect its climate; its climate acting upon the bed-rock largely determines the soil; the soil and climate together influence the vegetation; the vegetation reacts upon the soil; the climate, soil and vegetation are factors influencing the animal life, and this again reacts upon the soil and the vegetation; all these factors and others have a bearing on the utilization of the ground by man, and this utilization necessarily reacts upon the surface conditions and the plant and animal life; again, the climate of the area and the work that man does together influence his characteristics, and these react upon the way in which he modifies the area. In fact, in every area nature has formed a "complex" consisting of all these factors mutually influencing each other; this complex needs to be studied as a

whole, and none of the more specialized sciences undertakes that work.

Further, the earth's surface is made up of a vast number of such small areas, and the complexes formed upon them vary from place to place; where any one of the component factors is changed, e.g. the altitude or the climate, the whole complex is altered in all its aspects, and different kinds of complexes are found in different parts of the world. Consequently there is the need for a science to investigate the separate complexes and also their varieties and their distribution over the earth: that science is Geography.

The question at once arises as to what are the individual areas to be thus studied, and the answer to this question will depend on the nature of the investigation. Regions may be examined from particular points of view, e.g. climatologists mark out areas which have characteristic climates, while plant ecologists focus their attention on areas which have special kinds of plant-covering, but geographers have to take a broader view. They must look at the complexes as wholes, and a convenient way of doing this is to observe the "landscape," including not only the relief of the land and its plant-covering but also the animal life and the people, with all the signs of human activity such as towns, buildings, roads and fields. When, in traversing a country, one observes an obvious change in the character of the landscape, it is certain that a new unit-area or region has been entered, and examination will show to what the change is due, e.g. the relief of the land may be the distinguishing factor, and a greater altitude with steeper slopes will cause other variations, or perhaps man may have drained a district and turned it from a marsh into a polder-land with fields, roads and towns.

The following study of a portion of South-eastern England will mark out and examine the geographical regions which comprise this particular part of the earth's surface.

The South Downs.—To shipping coming up the English Channel, Beachy Head is a prominent landmark, a great head-land of white chalk capped with turf, projecting southward from the coast and rising to over 500 feet above the sea. It is the eastern extremity of the Sussex Downs, where for 50 miles behind the south coast,

Broad and bare to the skies,
The great down country lies;
Green in the glance of the sun,
Fresh with the keen, salt air.

Along its northern edge, the chalk plateau rises to a bold escarpment, whose massive front with gently undulating outline forms one of the most striking features of Southern England, and stands in marked contrast above the low, flat Wealden plain which it overlooks (see Fig. 1). From this edge, the dip slope of the plateau sinks gently southward. In the western portion it does not reach the sea, for there the chalk mass dips below deposits of loamy soils forming a narrow coastal plain, but in the eastern portion the chalk stretches to the coast and the southern part of the dip slope has been cut back by the waves to form a cliff edge. Throughout its length the plateau has certain common characteristics which depend upon the fundamental fact that chalk is easily permeable by water. The rain sinks into and through the surface, and there is consequently an absence of streams. This allows the chalk to remain relatively high while

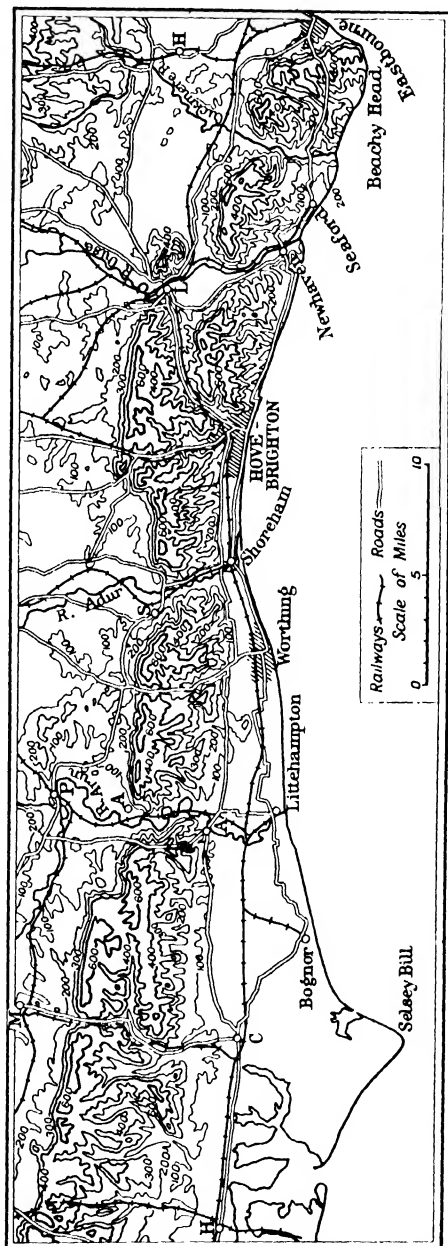


FIG. 1.—THE SOUTH DOWNS—A CHALK TRACT.

the clayey area of the adjoining Weald has been worn down by rivers to a lowland ; moreover, the surface of the Downs weathers into gentle undulations instead of having numerous sharply cut valleys. Further, the general lack of moisture in the soil makes it difficult for trees, except beech and a few others, to grow, but the dryness does not prevent the development of a vegetation cover of grasses and small herbaceous plants, such as the sweet-smelling thyme and marjoram and the brightly flowering rock-rose, vetch, bird's-foot trefoil and potentilla. The absence of water also makes widespread cultivation difficult, and much of the plateau remains a pastureland, supporting but few people in the small villages and scattered farms. These characteristics of the structure, relief, drainage conditions, vegetation and utilization of the South Downs mark it out as being essentially different from the neighbouring areas, with the exception of the wider mass of the Hampshire Downs into which it merges where Sussex meets Hampshire ; consequently the South Downs forms a small geographical region, which may be called a " tract " of country.

Yet this region is not uniform throughout its length : in the first place, the plateau is broken by the valleys of rivers which rise in the Weald and cross the region in slow, meandering courses to the sea ; in the second place, the higher areas between the river valleys are not identical but differ in minor ways from one another. Hence the whole tract is made up of units which need separate study, and to such geographical units the term " stow " is applied.¹ The South Downs consists of a group of four valley stows, those of the rivers Arun, Adur, Ouse and Cuckmere, and a group of five plateau stows which are separated by these valleys.

Scientific geographical investigation of a region must be carried out " in the field," by direct observation of all the phenomena of the stows and with the aid of maps on the largest scale available, but in this general course of Regional Geography only a summary of the result of such work can be given.

Plateau Stows of the South Downs.—These small regions have certain characteristics in common. Fig. 2 shows a part of the South Downs including a typical plateau stow, viz. that

¹ The word " stow," which was an old English word for " place," has been adopted because it is simple and because, not being already associated with some particular meaning, its use will not cause misunderstanding.

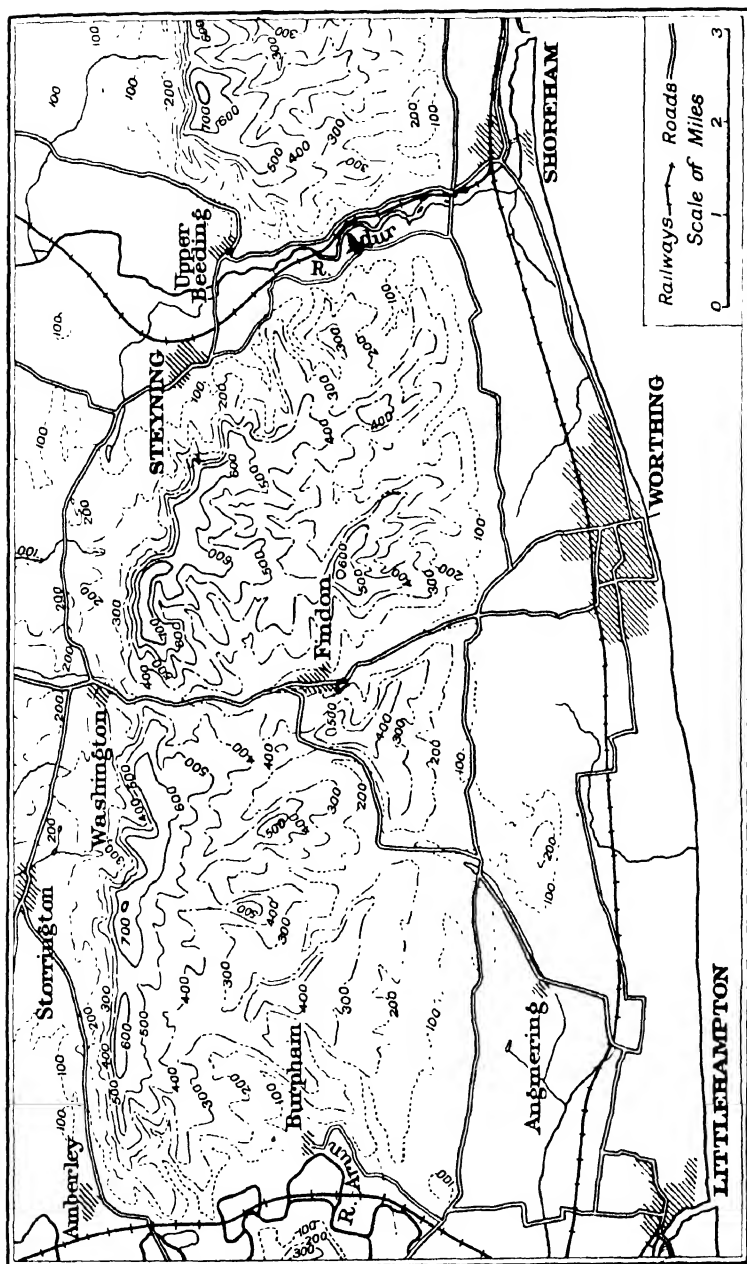


FIG. 2.—PLATEAU AND VALLEY STOWS OF THE SOUTH DOWNS.

between the Adur and Arun valleys, and a typical valley stow, viz. that of the Adur river. The plateau stows have steep north-facing escarpments rising to about 700 or 800 feet above sea-level, with almost cliff-like fronts diversified by hollows known as combes ; on the slopes of these combes, less wind-swept than the plateau, grow small woods and thickets of shrubs. These patches of trees and shrubs are frequently found where water seeps, or even springs, out from the chalk near the base of the escarpment above beds of impermeable marl or clay which hold up the water and prevent downward drainage.

On the plateau, however, water is seldom to be seen and wells would have to be dug to a depth of 200 or 300 feet or even more to reach the water-table, i.e. the level of the water which saturates the lower part of the chalk. On the higher parts, dew-ponds have been hollowed out and lined with clay to

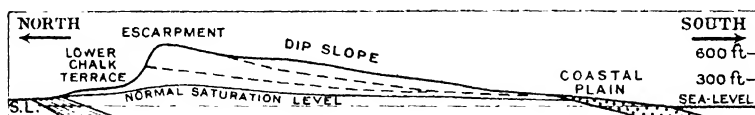


FIG. 3.—SECTION THROUGH THE SOUTH DOWNS.

Note.—The upper broken line shows the profile of a dry valley ; the lower one that of a wind-gap and valley.

retain water condensed from the atmosphere, but the wells are more easily dug in the “dry valleys.” These valleys lead southward from near the escarpment towards the coastal lowland or the sea cliffs. Also, the chalk escarpment is interrupted at certain places by valleys which lead, at a moderate elevation, from the Weald through the plateau, but no rivers now run through these “wind-gaps.” Both the dry valleys and the wind-gaps were probably formed long ages ago when the water-table stood higher than at present and when, in consequence, there was surface drainage, but now almost the only streams are the “winter-bournes” which appear in the lower parts of some valleys after prolonged rains have raised the water-table above the level of the valley bottom. The gradual weathering of the chalk on the sides of these wide, shallow valleys has resulted in the undulating appearance of the country.

In the chalk mass are beds of flints, and while the surface chalk is very slowly dissolved by the percolation of rain water containing acid derived from the roots of the vegetation, the

insoluble flints remain in the dark or reddish soil which thinly covers much of the plateau and collects to a greater depth in the valley bottoms.

The rainfall varies according to elevation ; near the escarp-

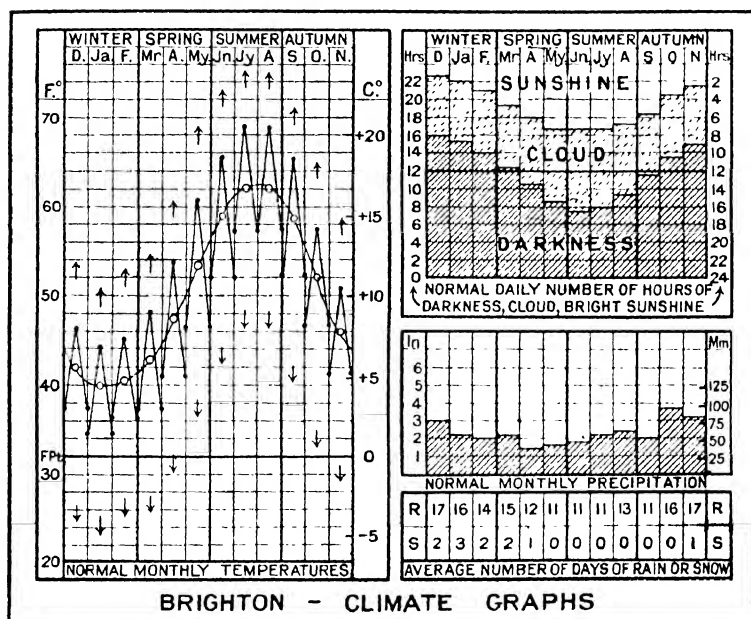


FIG. 4.—CLIMATE GRAPHS FOR BRIGHTON.

Note.—The normal temperatures, calculated over a number of years, are shown in the above diagram as follows:

1. The *average temperature* of all the day and night records during each month is shown by a circle; the curve joining the circles shows the *annual range* of these average temperatures.
2. The dot above each circle shows the *mean maximum* temperature for that month, i.e. the average of the highest temperatures recorded on every day of the month in question.
3. The dots below the circle, placed at each side of the space for the month to which they refer, show the corresponding *mean minimum* temperature for that month.
4. The lines joining the upper dot to the lower dots for the same month show the *mean daily range* for that month; these lines give an idea of the normal variations of temperature during the day at each period of the year.
5. The arrows pointing upward reach the normal *extreme maximum*, i.e. the highest temperature normally recorded during the month.
6. The arrows pointing downward reach the corresponding normal *extreme minimum* temperature of the month.

It will be observed that, by itself, the average temperature of any month, i.e. the temperature which can be deduced from the usual isothermal map, gives no idea of the normal range of temperature during the month.

ment the average annual amount is over 30 inches, but on the lower slopes it is not much more than 20 inches. Temperatures are of course lower on the more elevated parts of the plateau than near the coast, where the mean January temperature is

about 40° Fahr., and that of July about 62° Fahr.¹ While these climatic conditions do not differ greatly from those of other parts of South-eastern England, the dryness of the soil marks out this chalk plateau as a region with natural grasses or low bushes such as gorse or juniper; only in the western portion of the South Downs is there much tree growth, but there wide stretches of beech forest cover a large part of the stow which is situated west of the Arun valley.

The thinness of the soil covering and the lack of surface moisture make cultivation difficult on the uplands. Considerable areas are therefore reserved as open sheep walks, and the farming as a whole is directed towards sheep rearing, for even the arable land is utilized to produce fodder to a greater extent than crops for human consumption. Cultivation is best carried on in the hollows and valleys where the soils are thicker, and the farmers follow a rotation which alternates sown grasses or clover sometimes with wheat or oats, and sometimes with folding crops, i.e. crops such as rape, kale or swedes on which the sheep are folded to eat them in the fields. The sown grasses provide the hay for winter fodder, but during that season the sheep are generally moved down to the lower slopes of the chalk or to the richer pastures of the neighbouring regions—the coastal plain or the Weald. The plateau pastures are not fattening, and consequently the sheep are generally sold before they are a year old; moreover, these pastures are not rich enough for cattle, while the lack of drinking water is an additional reason for the pastoral work being mainly concerned with sheep, which need it less frequently than do cattle. There is a distinct “Southdown” breed of sheep, yielding good mutton as well as a fleece which, though short, is of fine quality.

The type of farming carried on in this tract requires and can support but few people as compared with more intensive agriculture, and, apart from the coastal towns, settlements consist of sparsely scattered farm-houses and small villages situated in the hollows and dry valleys where shelter and water are to be obtained. The coast is sunny and within relatively easy distance of London; consequently health and pleasure resorts have been established on the southern margins of the chalk country. The largest settlement is Brighton-Hove; this is

¹ These statements as to rainfall and temperatures should be studied in connexion with the isohyets and isotherms shown on the climate maps in an atlas.

only about 50 miles from London, with which it is connected by a railway taking advantage of a wind-gap in the chalk escarpment, and in 1931 it had at the census time of April (i.e. out of the crowded holiday season) a population of over 200,000 people. To some extent Brighton may be regarded as a seaside suburb of London, for many families live there whose members make frequent, even daily, journeys to the capital for business, shopping or pleasure. Near the seaside resorts golf-



FIG. 5.—IN THE OUSE VALLEY OF THE SOUTH DOWNS.

The view is taken from the river bank across the flat, low pasture bordered by the railway embankment. The chalk plateau, scarred by a great quarry, rises steeply in the background.

courses have been laid out on the Downs, and parts of the open grasslands have been utilized for race-courses and training grounds for the horses.

It will be realized that each of the chalk plateau stows is composed of several quite small areas of the earth's surface which have distinctive characters, e.g. the steep escarpment, the open grassy plateau, the more sheltered valleys with arable land and farming settlements. These individual areas may be called the "features" of the stows, for they give to the stows their characteristic appearance. The features just named are

common to all the stows, and so represent the common features of the whole tract of the South Downs, but there are others which are found only in particular stows, such as the northern part of the great settlement of Brighton-Hove which has spread from the coastal plain on to the stow lying between the valleys of the Adur and Ouse, and the extensive beech woods which clothe much of the stow between the Arun valley and the Hampshire boundary.

Valley Stows of the South Downs.—Each of the four rivers crossing the Sussex Downs has cut a valley which is now but little above sea-level and is floored with alluvium. The length of these valleys corresponds with the width of the Downs, about 4 to 6 miles, and their breadth is about half a mile. Their flat floors are in marked contrast to the slopes of the chalk which rise on either side. As the valleys are almost at sea-level, there can be no downward drainage, and the soft alluvium is frequently water-logged in winter and occasionally flooded; the rivers are tidal and the banks have to be raised to protect the low country from periodic inundation. Dykes and drainage channels divide the flat land into small compartments; the meandering streams swing from side to side of the valley, and in their slow development leave old channels and “cut-offs” which remain filled with water and add to the difficulty of crossing the area. These wet levels (called “the Brooks” in some parts) are of little value except for herbage, and usually the only signs of life visible upon them are herds of cattle, many sea-gulls and other birds.

Cultivation is almost entirely limited to the margins of the valleys where the land is a little higher, and to certain small island-like areas that rise from the flood plain; on these higher lands are the farm settlements, occasionally grouped into villages. The roads connecting the settlements wind along one or both sides of the valley for most of their courses; only the railways, which must keep a straighter route, cross the low ground on embankments. The valleys of the Adur, Arun and Ouse are utilized by railways connecting the London region with the sea, and the ends of the valleys are in almost every case marked by larger settlements. The largest of these is Lewes, where the northern end of the Ouse valley opens upon the Weald. Lewes is not merely a gap town, but also at the nodal point of routes which lead to all parts of Sussex; hence its past development as the administrative centre, the “capital” of the county, and

an important market town, and its present position as a railway centre. It has grown so that it now extends from its original site on the western side of the Ouse valley, where the castle stood on a defensible chalk knoll, across the lowland to the opposite side of the valley, where the steep flank of the upland has been scarred by great quarries to obtain chalk for lime and cement works.

At the southern end of the Ouse valley, the harbour formed by the river mouth has given rise to the port of Newhaven,



[Judges' Ltd.]

FIG. 6.—A TYPICAL CHALK-DOWN SKYLINE.

The high downland in the background is not, however, in the South Downs, but in the Isle of Wight. The view is taken southward across Sandown Bay on the east coast; on the right are low cliffs of Lower Greensand which (as explained in Chapter V) dips below the chalk forming the downland of the south of the island.

one of the "ferry-towns" of the passenger and goods traffic across the Channel. Similarly at the south end of the Adur valley is the harbour and small port of Shoreham, while the small country town of Arundel has grown up where the valley of the Arun opens upon the narrow coastal plain.

The individual features of the valley stows are obviously different from those of the plateau stows, and comprise the following areas: the wet, grassy flood plain; the numerous

water-surfaces of rivers, old channels and drainage ditches ; the marginal strips of cultivable lands with houses and roadways ; the larger town settlements at the ends of the valleys. These small areas are essentially interconnected, for the alternate wearing and depositing action of the river determines alike the courses of its meanders, the situation and extent of the marsh lands and the limits of the firmer ground. The relative positions and interrelations of these areas must clearly be studied together ; hence they are regarded as merely the features of a stow, while the most convenient units of study are the valleys as wholes.

Yet even the separate stows must not be considered as entirely independent regions, for they are by no means unrelated to each other ; for example, the significance of the valleys as means of communication is due to the existence of the plateau stows which restrict traffic to them and thus affect the development of the settlements at the valley ends.

Thus the tract of the South Downs is regarded as a series of stows of two types, plateau and valley, and the characteristic landscapes of the tract are due to the individual features of the stows and their relative extent and position.

Orders of Regions.—A stow may be shortly defined as the smallest unit-area of geographical study : a region of the first or lowest order. The South Downs afford a good example of the fact that a number of adjacent stows have certain resemblances, and may therefore be grouped together to form a larger area which, although not so simple in its constitution as a stow, yet has enough common characteristics to form another definite region : a tract, or region of the second order.

In successive chapters of this book it will be shown that the South Downs are bordered by other tracts which resemble it in certain ways, and these may be combined into a larger area, the English Lowland, which includes all England except the Uplands of the North and West ; the term “ sub-region ” is applied to such a region of the third order.

Similarly a number of sub-regions may be grouped together to form a still larger area, which comprises the English Lowland and the somewhat similar lowlands of the continent of Europe, extending from France through the Low Countries and Germany to Poland ; since these areas have a markedly temperate climate they are called the *Mid-Temperate Lowlands of Europe*. For this fourth order of region the term “ minor region ” is used.

Finally, this minor region may be combined with adjacent minor regions which, although different in being either more elevated or in having rather more equable or extreme climatic conditions, yet still have a climate to which the term "temperate" can be applied. This extensive area occupies most of Western and Central Europe and it may be called "Temperate Europe"; it is one of the "major regions" of the world.

The idea of such major regions is now familiar, and has proved very useful in the study of Geography; the present scheme, therefore, relates the smaller areas to these immense ones in a way which may be set out as follows :

STOWS,	regions of the 1st order, grouped into						
TRACTS,	"	"	"	2nd	"	"	"
SUB-REGIONS,	"	"	"	3rd	"	"	"
MINOR REGIONS,	"	"	"	4th	"	"	"
MAJOR REGIONS.							

A difficulty now presents itself, for it would seem that by this method all the stows of all the world should first be worked out and examined; before any general conception of the world could be obtained, these stows should be combined into tracts, the tracts into sub-regions, the sub-regions into minor regions and the minor regions into major regions. That would be an ideal method of proceeding, from the point of view of accurate, scientific work, but it is obviously not practicable, if only because of the lack of knowledge about great areas of the world. Also such a study would require an encyclopædia for its presentation, and in a general course such as the present the method must be modified.

The scheme here adopted is to deal with certain stows in some detail, as has already been done in the case of those of the South Downs, and will be done in respect of some other parts of South-eastern England, but space will not allow of this treatment being continued. For the greater part of the British Isles, the tracts must be the smallest units of study, and their characteristics must be described in general terms, the stows which comprise them obtaining scanty reference. As the survey extends, so the regions of higher order are treated as the units: over some of the more important parts of Europe tracts may be separately examined, but over other parts of this continent the sub-regions must be the smallest areas considered separately, and

in the more distant parts of the world only minor regions, or even major regions, can usually be treated as the units. Yet it must always be borne in mind that these vast areas, though described in general terms which might perhaps seem to suggest that they are uniform in their conditions, are in reality very complex and composed of a great number of differing regions of lower orders.

Indeed, the world is so infinitely varied that no simple arrangement can present it with any degree of accuracy ; as this course proceeds, the actual conditions of some areas will be found to demand modifications or complications of the simple scheme of five orders of regions. But these and other difficulties can be left until later.

One more general idea, however, may be considered at this point, in connexion with the human aspects of the study. Confusion has in the past occurred in the use of the phrase "natural regions," as the word "natural" is often intended to mean "physical" as opposed to "human." For this reason, the term "geographical regions" seems preferable, in order that the human element may not appear to be excluded ; without considering man and his works, the complexes cannot be adequately studied. It is true that human action has not had much influence in determining the conditions of the great major regions of the world or of the other regions of the higher orders ; for example, a desert region such as the Sahara remains in general a desert even though small areas are irrigated and become fertile oases ; these regions of high order might therefore be considered as physical regions in so far as they are distinguished from adjoining regions by their physical conditions, but even in them the more detailed phenomena are influenced by man.

When, however, we attempt to mark out the regions of lower orders, particularly the stows, we frequently see that the action of man has been the cause of making a region stand out from its neighbours ; the oases of the deserts give good examples of this, and in a later chapter it will be shown that London is a man-made stow.

A little thought will show that in the view of Geography here taken, it is regarded not merely as "the study of the earth as the home of man," but as a science involving the interrelations of *all* the phenomena of the earth's surface. The human side

of Geography may be given special attention, however, on the ground that one great value of the subject is in showing how the various peoples of the world are related to their respective environments, and how their natural conditions affect their work and way of life, and even their relations to neighbouring peoples.

After this general explanation of the methods adopted, we return to the study of South-eastern England.

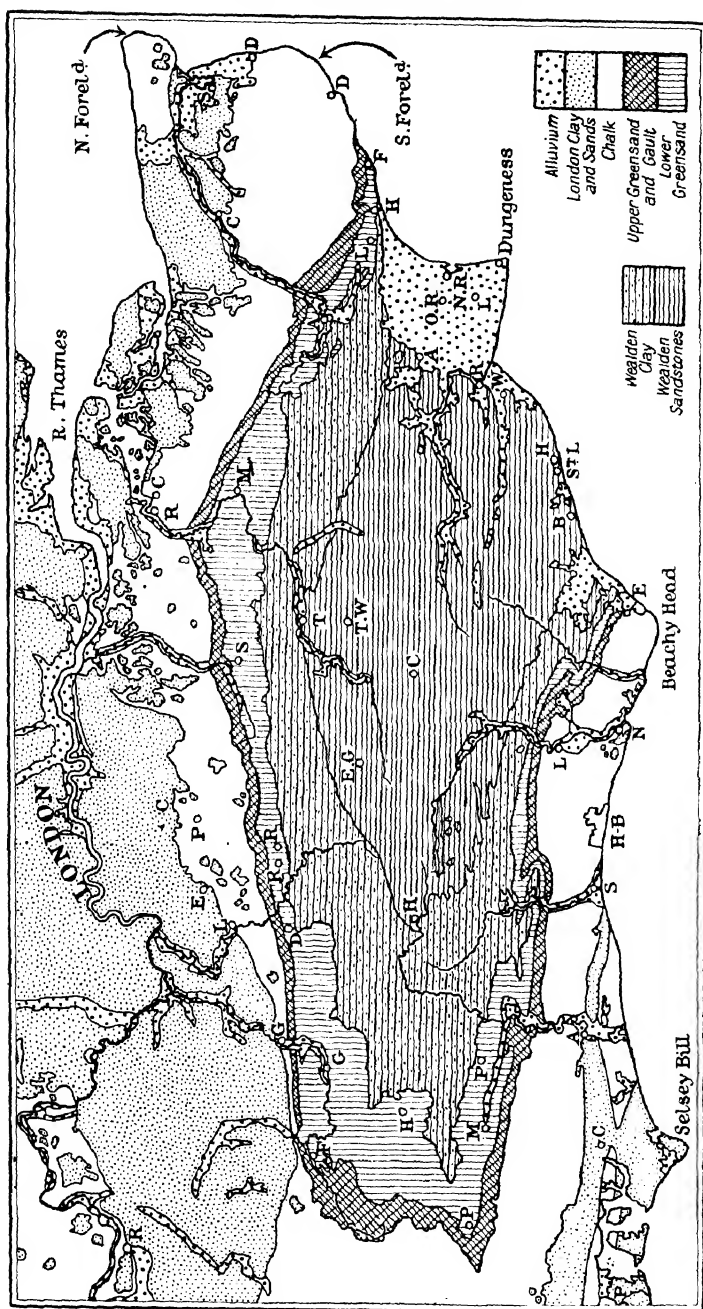


FIG. 7.—GEOLOGY OF THE WEALD AND DOWNS.

Note.—This map shows the "solid" geology, and not superficial deposits such as clay with flints or glacial deposits.

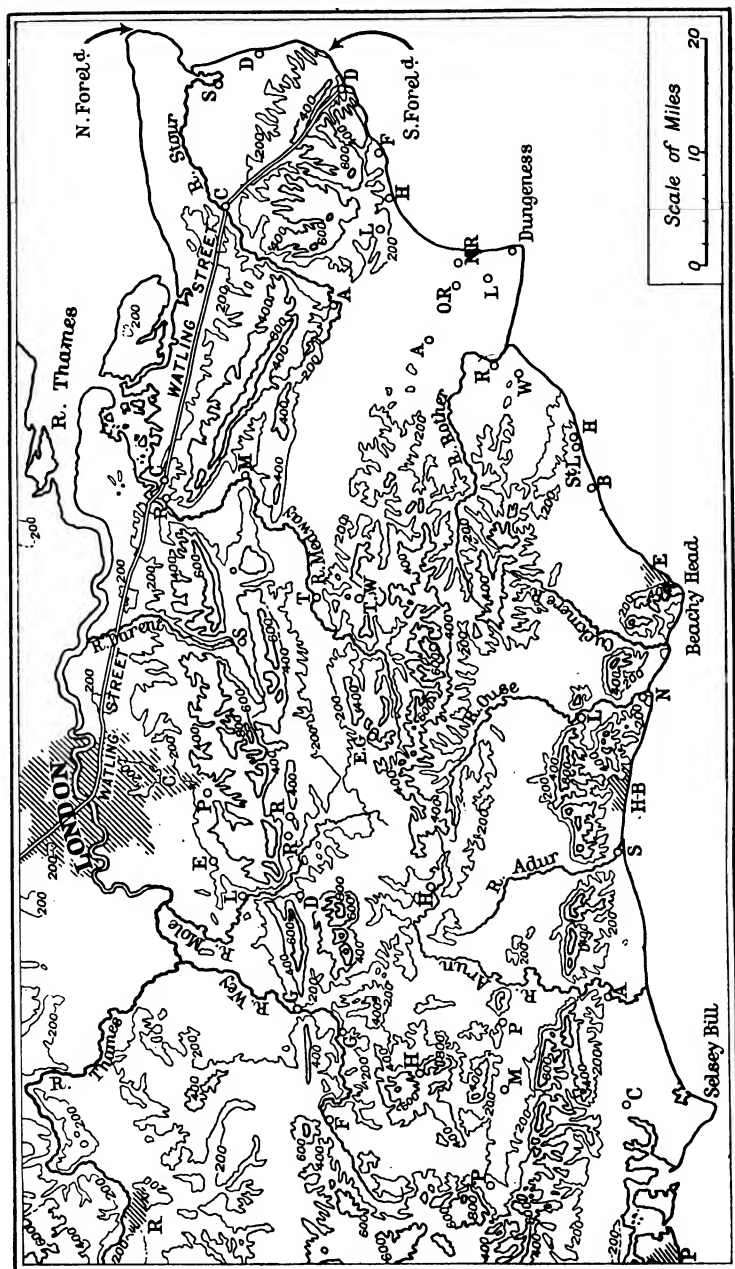


FIG. 8.—RELIEF OF THE WEALD AND DOWNS.

CHAPTER II

THE WEALD AND THE NORTH DOWNS

The Weald.—For many centuries much of the chalk country of the south-eastern corner of England—the South Downs, the Hampshire Downs and the North Downs—was open grassland, which enclosed a densely wooded area known as the Weald. Nowadays, a good deal of the grassland has been ploughed and a good deal of the forest has been cleared, but the Weald still appears very different from the surrounding Downs. Since it has a certain unity of position and structure and possesses certain common characteristics, it may be considered as a geographical region, and since it is composed of a number of stows, it is a region of the second order—a tract. In this book, the individual stows will not be demarcated and examined separately, but it will be shown that in the Weald there are three distinct types of stow corresponding to three distinct types of country. In order to understand the nature of these types of country and their arrangement in the region, the general structure of the Weald must first be considered.

The Structure of the Weald.—From the geological section in Fig. 9, and the map in Fig. 7, it may be seen that the Weald is the central portion of a dome-shaped upfold or anticline which has had its top denuded and its south-eastern part worn away. When the dome was first upraised, rivers ran outwards from the central and highest portion, cutting radiating channels, the forerunners of the present valleys which now cut across the chalk plateaus of the North and South Downs. Then gradually all the high ground was denuded until there was produced a peneplain, almost level and gently sloping towards the sea. At this stage the top of the dome had been, as it were, completely planed off and in the centre appeared the lowest of the layers, the Wealden Sandstones, around which showed belts of the higher beds, the Wealden Clay, the Lower Greensand, the Gault Clay and Upper Greensand, and the Chalk. While these belts of varied powers of resistance were all near

sea-level, the streams ran so slowly that further wearing could not occur even in the weakest material; hence their almost uniform elevation.

Later, however, a change took place in the relative level of land and sea, and the peneplain became a plateau which was probably not very much higher than the highest parts of the region at the present time. With the new elevation, the streams were rejuvenated, the original or "consequent" rivers deepening their valleys through the chalk, and their "subsequent" tributaries wearing down the belts of clay which were less resistant than the chalk and sandstones.

Thus the more resistant chalk and sandstones have maintained something of the height they had as an upraised peneplain, and form plateaus and ridges ranging from about 800 to nearly 1,000 feet above the sea; the less resistant clays have been worn

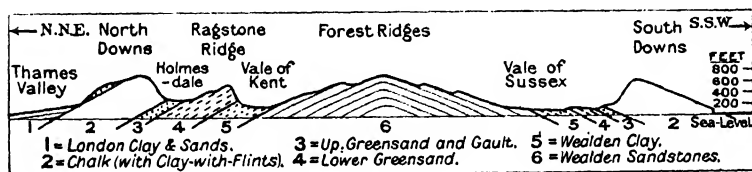


FIG. 9.—SECTION THROUGH THE WEALD AND DOWNS.

Note that in this and the succeeding sections the vertical scale, and consequently the heights and slopes, are greatly exaggerated.

to vales which in the upper parts of the river courses (e.g. in south-west Surrey) may be about 200 feet in elevation, but towards the English Channel sink almost to sea-level.

The escarpment or scarped edge of the chalk, which on all sides of the Weald looks inward towards the centre, is steep because it has been undercut by the springs and streams which have worn away the less resistant Upper Greensand and Gault clay beneath it; similarly the steep escarpment of the Lower Greensand belt looks inward over the broader belt of the Wealden clay. Just as the dip slopes of the chalk sink gently outward away from the centre, so the dip slopes of the Lower Greensand decline in the same outward direction. The Wealden sandstones in the centre dip outward towards all sides; hence they are highest in the centre and sink gradually towards the surrounding plain of the Wealden clay. Thus, in the Wealden tract, erosion acting upon the anticlinal structure of successive

layers of sandstones and clays has resulted in the emergence of the following more or less concentric belts of country.

1. In the centre is a hilly region, the High Weald, composed largely of sandstones ; these reach the sea at Hastings, and geologists name them the Hastings Beds.

2. Around this nucleus a wide, flat plain, formed mainly out of the Wealden clay, constitutes the Vale of Kent in the north-east, the Vale of Surrey in the north-west and the Vale of Sussex in the south.

3. A strip of more irregular relief is formed by the Lower Greensand. It appears as a rather narrow band, called the Ragstone Ridge, in Kent and eastern Surrey on the north-eastern edge of the Wealden clay (south of the towns Maidstone and Sevenoaks and extending westward as far as Reigate and Redhill) ; in the west the Lower Greensand stands up as a bolder and broader mass in western Surrey, rising to nearly 1,000 feet at Leith Hill near Dorking, and forming Hindhead and Blackdown on either side of Haslemere ; it becomes less marked in Sussex, changing from a distinct ridge in the west, north of Midhurst, until it disappears entirely in the east.

4. Still farther from the centre a narrow plain, chiefly of Gault clay, appears between the Lower Greensand Ridge and the surrounding chalk. It may be clearly seen between the Ragstone Ridge and the North Downs, where it bears the name of Holmesdale ; westward, it is at first not to be distinguished from the Wealden clay plain, but north of Leith Hill it reappears as a very narrow strip, and widens again between the uplands of Hindhead and Blackdown on the one hand and the Hampshire Downs on the other. In Sussex the Gault clay plain is fairly broad between the Midhurst Ridge and the South Downs, but as the Greensand Ridge disappears eastwards this clay area becomes merged into the Vale of Sussex, which therefore is formed partly of Wealden clay and partly of Gault clay.

To avoid misunderstanding the geological maps, a distinction must be drawn between the geological and the geographical grouping of strata. The geologist arranges the rocks according to their age, classifying together those which are proved, by the fossils contained in them, to have been formed at the same time in the history of the earth's surface. Yet at one place the rocks of a given age may be of a certain material and at another place contemporary deposits, which therefore bear the same time-

name and are shown on the geological map by the same marking, may be of different material. Again, the geologist finds it necessary to distinguish between rocks, because they were formed at different periods of the earth's history, even though they are of similar composition.

On the other hand, the geographer does not find the age of the rocks in itself important. He is concerned rather with two other matters : first, the material of which the rocks are composed, and second, their arrangement, e.g. whether they are in layers, and if so how these layers are superimposed upon one another, for it is the material and arrangement of the rocks which have an influence upon the geography. Thus in grouping together the rocks of the Wealden region, the geographer finds it appropriate to classify the Wealden sandstones with the Lower Greensand as being of similar material and forming similar country, and to classify the Wealden clay and the Gault clay together for the same reason.

The Wealden tract, so far as hitherto considered, is therefore formed of stows of two main types : (1) those in which sandstone forms the chief subsoil, and well-marked ridges are the chief features of the relief, and (2) those which form relatively broad vales worn down from belts of clay. These may briefly be termed the "sandy ridge" and "clay vale" types.

In addition, there are two coastal flats which adjoin and somewhat resemble the vales of Kent and Sussex and may be treated as a part of the Wealden tract. These are the alluvial areas of recent formation commonly known as Romney Marsh between Hythe and Winchelsea, and the Pevensey Levels between Eastbourne and Bexhill ; they represent a third type of stow : the alluvial marsh.

The "Sandy Ridge" Stows.—These stows are found in two groups : the central region of the High Weald forms the first group, and the belt of hilly country of the Lower Greensand forms the second group. The stows are not simply high ridges, for the rivers have cut deep valleys, particularly where thin beds of clay interrupt the sandy layers. Moreover, the geological map differs considerably from the relief map, for some of the layers classified as "sands" are composed of such fine-grained material that they are scarcely to be distinguished from clays. Therefore, in the eastern part of the area, which is shown as "Wealden Sands" or "Hastings Beds" on geological

maps, much of the country is low and in its features little different from the plain of the Wealden clay. The relief map shows that the central hilly area of the Sandy Ridge type is relatively broad in the longitude of Tunbridge Wells, but on its south-eastern side it is broken by the clayey valley of the Rother, and consequently the hill country is reduced to little more than a single ridge which reaches the sea in the cliffs by Hastings and is called the Battle Ridge ; the Battle of Hastings was fought near its lowest crossing-place.

The High Weald reaches its greatest elevation at Crowborough Beacon, just over 800 feet in height, in the central district known as Ashdown Forest. At the western extremity is St. Leonard's Forest, and other areas are also named "forests"; hence the whole hilly area has been called the Forest Ridges. Much of the higher country is actually forest, in our modern use of the word, pines being common ; but other elevated parts are heathlands, covered with heaths and other shrubby growths and grasses, while there are also wide areas of an intermediate stage called "Oak-birch heath."

The streams have cut deep and often steep-sided valleys into the hill country ; in the bottoms of some of the valleys are exposed beds of clay, and these have been worn down to produce flat and occasionally marshy river-bottoms.

The variation of relief frequently corresponds with differences in the vegetation covering and in the use of the land. The higher areas are of little value except for coppices or as poor pasture, but on the lower lands there are orchards and hop gardens, especially in the north-eastern or Kentish area, while in the same district swampy river-bottoms have been turned into productive meadows.

The extremities of the High Weald are the least utilized : in the west the uncultivated "forests" are still very extensive, while in the east the Battle Ridge is heavily wooded with oak and chestnut trees and there is little farming. But in the central portion, and particularly near the railways leading to London, there is a fair amount of dairy-farming, and recently poultry-keeping has developed ; on the other hand, unused oast-houses in the Kentish area mark the decline of hop-growing.

The settlements of the High Weald are mainly on the ridges, and the roads avoid crossing the numerous and steep-sided valleys and follow the water-partings ; consequently the larger

villages and small towns of the region have developed at the meeting-place of these ridge roads, as for example at East Grinstead. The health and pleasure resort of Tunbridge Wells owes its growth to the existence of chalybeate springs in a pleasant environment. Where land of moderate elevation reaches the sea between the Pevensey and Romney Marshes, the seaside resorts Hastings-St. Leonards and Bexhill have been built.

The features of the stows comprising the belt of Lower Greensand resemble in general those of the centre of the Weald. In south-western Surrey, Hindhead and Blackdown have a steep escarpment facing eastward and overlooking the Wealden-clay plain; their highest parts are largely either sandy heathlands covered with heather, gorse and rough grass, or woodlands with pines, larch and birch; but in recent years well-to-do people have built houses in laid-out grounds that they may enjoy the scenery and the wide views. On the lower part of the dip slope towards the source of the River Wey there is better soil and more farming. This greater productivity, with the consequent greater population, is still more marked in the neighbourhood of the Wey near Godalming where the Lower Greensand dips northward and is covered by more fertile soils.

Leith Hill and its neighbours are more wooded than Hindhead, but east of this high mass the Lower Greensand belt narrows and has been worn almost to a lowland. Continuing eastward, the sandy ridge type of country widens from near Redhill, particularly in the Kentish portion, and here it is more utilized by man. There are still sandy commons and woods near the south-facing escarpment, but conditions are different where the lower part of the dip slope adjoins the Gault-clay bottom of Holmesdale. On the southern side of this vale, from west of Sevenoaks to east of Maidstone the sandstone weathers into a productive soil and farming here profits also by a sheltered situation; man has long worked this ground and carefully manured and tended it. Here, too, the River Medway has cut through the Greensand escarpment and deposited in the valley alluvial soils of great fertility. The lower areas in this part of the Greensand belt are therefore very different from the unproductive ridges, and may give some justification to the people of Kent in calling their county "the garden of England"; the part around Maidstone has indeed been termed "the garden of Eden." Apples are appropriately one of the chief productions of

the orchards, and cherries, plums and gooseberries must also be mentioned, while hops are grown over considerable areas.

The Weald is the most important region of hop cultivation in England ; the centre of production is situated south-west of Maidstone especially on the recent alluvium of the River Medway and on the earlier loamy deposits, known as " brick-earth," found in the Medway valley. The cultivation of hops has extended also over other fairly rich soils on various geological formations in neighbouring parts of Kent. The hop gardens, with the plants spreading over the high poles, are a characteristic sight of this district, as are also the oast-houses, with their conical tops and hooded chimneys, in which the hops are dried. At the end of the summer, the picking is carried on by immigrants from the poorer parts of London ; whole families engage in the work and special trains are arranged for their conveyance. The farmers generally grow hops on the lower lands and fruit on those situated rather higher ; when the price of hops goes down and does not pay for the labour and other costs, there is a tendency to restrict their cultivation and to increase that of fruit.

Along the southern edge of Holmesdale is not only a belt of productive farming but also a line of settlements, for in building these and making the road which joins them men have taken advantage of the dry sandy soil and avoided the wet Gault clay. Where routes from north to south cross this line towns have sprung up, the largest being where important north-south roads lead through the chalk plateau which forms the northern boundary of Holmesdale.

Maidstone is in such a position ; it is on the River Medway, which has cut a valley through the chalk to the Thames estuary, and it is situated where the east-west road crosses the river. It is almost in the centre of northern Kent, the most productive and most densely populated part of the county, and from it routes lead easily to all parts ; this situation of Maidstone naturally led to its becoming the county town of Kent.

In the western part of the same productive belt of the Lower Greensand and at the southern end of the Darent gap through the chalk is Sevenoaks ; in the eastern part of the belt and near the Stour gap is Ashford. At the eastern extremity of the Greensand, where it is cut short by the sea, is situated Folkestone, one of the Channel ferry-towns and a seaside resort ; near it is

Hythe, which was once a port though the old town is now half a mile inland.

Similarly, and for the same reasons, the lower part of the Greensand belt in Surrey is marked by both small and large settlements. The twin towns, Reigate and Redhill, are where the east-west line is crossed by the shortest routes going southward from London to the sea, and farther westward Dorking and Godalming are situated near the southern ends of the gaps of the Mole and Wey respectively. At the north-western corner of the Weald is a wind-gap through which the upper course of the River Wey probably once flowed northward to the Thames, before it was captured by the subsequent reach of this river above Godalming; south of this gap, the small town of Farnham has grown up. In the south-western corner of the Weald, Petersfield has a somewhat analogous position where the road from London to Portsmouth traverses the lower edge of the Greensand belt, though there is not so marked a gap in the chalk plateau to facilitate its crossing. In Sussex, settlements are similarly placed on the lower part of the Greensand belt, but as they are more remote from the populous London region and not concerned with such important traffic routes, even the largest of them, such as Midhurst and Petworth, are little more than villages.

The "Clay Vale" Stows.—These regions are generally of less interest and importance, for they are mainly flat, relatively low areas, floored by a heavy, impermeable clay on which drainage is difficult. Only where this work has been carried out is cultivation easy or productive, and in general the country either remains a woodland with oak or ash (the latter especially in the wetter parts), or it is used as a rather unproductive grassland. Seen from the escarpment of the South Downs, the broad stretch of the Vale of Sussex may appear more completely wooded than it really is, for the roads are commonly lined with trees, and trees remain also scattered in the fields and along the hedgerows. It is easy to imagine how the clay vale was once a dense forest, but the firm modern roads give no indication of the quaggy tracks which in past centuries were impassable in wet weather. Till relatively recently these clay vales were little more than a barrier to movement, avoided by settlements and utilized only for their timber and poor pasture. The farming is generally still poor, the settlements are small and the total population is

scanty ; this is particularly true of the broad areas of Wealden clay in Sussex.

The Kentish clay vales, however, are more productive and better populated, partly because of their better soil conditions and partly because of their nearness to more favoured regions from which cultivation has spread gradually over the clay land, though during bad times the less favoured areas are the first to suffer and show a decline in agriculture and population.

For example, in the clay area of south-eastern Kent, sheep farming and the growing of fodder have spread from Romney Marsh (which will be described in the next section). Still more important is the extension of agriculture in the Vale of Kent in the neighbourhood of the Medway, particularly the growing of fruit south of Maidstone and of hops east of Tonbridge ; here, however, loamy brick-earth, which covers the clay, and the recent alluvial soils brought down by the Medway have made the natural conditions much better than is usually the case in the Wealden-clay regions.

Holmesdale and other vales of the Gault-clay belt are more productive than most of the Wealden-clay belt for similar reasons. These narrow vales have gained by admixture with the sandy material brought by rivers from the Lower Greensand belt, and also in parts by the downwash from the chalk escarpment which bounds them on the other side. Moreover, farming has relatively easily spread across them ; this fact is connected with the shape of the parishes, which are commonly narrow and long, extending across the Gault-clay belt over a part of the Lower Greensand on the one hand and a part of the chalk on the other. Thus, as a rule the inhabitants lived in a village grouped round a church on the dry Greensand, and utilized parts of the different natural regions extending across their parish as open chalk Downs for sheep, clay lowland for timber and the lower sandy soils for agriculture.

Similarly in the more central part of the Weald, the parishes commonly stretch over both Wealden clay and Wealden sandstone. The settlements were conveniently placed on the edge of the sandstone, and villages now frequently mark the boundary between these two regions ; Horsham at the western extremity of the central sandstone has grown to the size of a town.

In the west and the south of the Wealden area the Gault-clay belt has a further modification, for in those parts, between this

clay and the chalk, appears a narrow bed of sandy loam known as the Upper Greensand, as well as a bed of marl which the geologists include in the "lower chalk." These beds of loam and marl sometimes outcrop to form a low, fertile terrace between the clay hollow and the steep chalk escarpment (see Fig. 3). Where the lower part of the chalk forms a strip of low, fertile land different from the Downs in its altitude, its vegetation cover and its utilization by man, it must be considered by the



[*"The Times"*]

FIG. 10.—THE VALE OF SUSSEX AND THE CHALK SCARP.

In the background are the South Downs; in the middle distance are fields on the lower chalk marl; in the foreground the clay soil gives pasture for the sheep which will be sent up on the Downs later in the year.

geographer as belonging to a different region from that of the main mass of the chalk; hence in this case the boundary of the geographical region does not quite coincide with the boundary of the chalk as shown on the geological map.

This narrow belt of loam and marl is very suitable for settlement; underneath the edge of the South Downs, for example, has sprung up a line of hamlets and villages. Where this belt came out to the sea north-east of Beachy Head was the small settlement of Eastbourne, which has now grown into a large seaside resort and spread over the lower part of the chalk Down.

The "Alluvial Marsh" Stows.—The stow of Romney Marsh, including the other marshes which adjoin it and are commonly known under the same name, has been formed by four main agencies. First, the sea currents have drifted eastwards masses of shingle composed of material worn away from the south coast of England, and banks have been formed off the shore enclosing shallow lagoons. Second, the rivers entering these lagoons have deposited sand and mud, and filled them to about sea-level. Third, on the land thus formed vegetation has grown, though subject to inundations, and this vegetation cover has itself contributed to the building up of firm land. Lastly, man, gradually and over a period of several centuries, has protected the low flats by building a sea-wall where high tides threatened, has drained them by dyking and ditching, and has utilized them by replacing the natural grasses by sown varieties and, to a small extent, by other crops. The natural processes still cause changes in the region, though more slowly than in the past.

The "features" of this stow include the great projecting mass of shingle known as Dungeness, lines of almost bare sand-dunes along the coast, the wide expanses of the "marshes" or "levels," and the close network of streams, ditches and "sewers." The region extends as far inland as the old coast, which can be traced in a great curve of low cliffs from Hythe past Lympne and Appledore to Rye and Winchelsea. The ports of these small towns are now silted up, but Lympne has been made the site of an aerodrome for air routes of far greater range than the sea voyages for which the ports served centuries ago. Lydd in the heart of "Dunge Marsh," is another ancient port, and both Old Romney and New Romney are now inland.

The present importance of Romney Marsh lies in its sheep-rearing. The reclaimed salt marsh has become an excellent pasture land, bearing great numbers of sheep. These are of a special breed, the "Kent" or "Romney Marsh" sheep, large and hardy animals, protected by a close fleece of long wool. They can survive both the diseases due to the wetness of the soil and the bitter winter winds which blow with tremendous force across this open, treeless land exposed to Channel gales. The contrast between the Romney Marsh and the Southdown sheep is an example of the adaptation to environment which man has consciously brought about in the animal world.

The ewes live in the open, and can find their own grazing on the rich pastures all the year round ; the lambs are born late in April and remain on the marsh till near the end of summer, but they cannot withstand the winter and are sent away by road or rail to the interior of the Weald, more particularly to the lower parts of the sandy areas. They return in spring, are fattened during their second summer, and are then sold, unless retained for breeding.

Pevensey Levels form another stow, of the same type and of similar origin. This region is, however, differently utilized, for it mainly supports cattle, young bullocks being brought from the adjoining Vale of Sussex to be fattened on the pastures.

These examples of the small regions of different types which form the Weald show how their natural differences have led to their development in different ways ; man has made them complementary to one another, and they are now related by their economic activities in addition to being related naturally to one another by the physical processes which have brought them into existence and still contribute to their characteristics.

The North Downs.—On its northern side, the Weald is bounded by the North Downs, a tract which resembles the South Downs in being composed mainly of stows of the chalk-plateau type ; it may therefore be termed a chalk-plateau tract, although it also comprises certain valley stows.

The Plateau Stows.—The North Downs may be considered as beginning east of the Farnham wind-gap, with the narrow chalk ridge known as the Hog's Back. Here the sheet of chalk is steeply tilted northward, and consequently there is no broad plateau as is the case where the chalk has a gentle dip, but only a very narrow outcrop of about half a mile in width with a northward slope almost as steep as the south-facing escarpment. The ridge is not so high as most parts of the chalk escarpment, for it reaches little more than 500 feet above the sea.

Eastward, however, the dip of the chalk becomes less steep, the outcrop is wider and the plateau assumes its usual form. The Wey breaks through in a gap of about a mile long, while the Mole valley forms a small stow 5 miles in length. Between this valley and that of the Darent, the chalk widens to a breadth of approximately 7 miles, and reaches the greatest height of the North Downs, about 880 feet, near the boundary between Surrey and Kent. In this plateau stow, and in the next one

between the Darent and the Medway, there is a general trend of the whole region from W.S.W. to E.N.E. which brings the lower part of the dip slope close to the estuary of the Medway; still farther east the trend again changes and becomes N.W. to S.E.

There is also a gradual widening of the plateau, so that between the Stour and the Strait of Dover the chalk has its greatest width, the lowest part of the dip slope extending almost to Sandwich and Deal. Here, too, a new feature of the relief makes its appearance, for while all the chief valleys hitherto observed in the chalk uplands are transverse to the general trend of the plateau, as is the Stour between Ashford and Canterbury, there is here a hollow forming a nearly continuous line from Dover to Canterbury in a longitudinal direction, almost parallel to the escarpment. The eastern end of this longitudinal hollow is occupied by a small stream which reaches the sea at Dover. The Roman "Watling Street" followed this line from Dover to Canterbury, and until the construction of railways very much of the traffic from the Continent to London took the same route.

The relatively low portion of the dip slope of the chalk lying north-east of this longitudinal hollow is different from the adjoining parts of the North Downs to so marked a degree that it is convenient to study it separately, and it may therefore be considered as a distinct stow; from the fact that its seaward edge forms the cliffs of the South Foreland, it may be termed the South Foreland stow.

From the point of view of climate, there is not a great deal of difference between the North and South Downs, though the former has rather less equable temperatures and rather less rainfall and is less wind-swept—all due to its situation being more sheltered from the prevailing south-westerly winds from the Channel.

With the exception of the South Foreland stow at the eastern extremity of the North Downs and the Hog's Back stow at the western extremity, this tract differs markedly from the South Downs by much of the chalk surface being covered by a layer which is commonly known as "clay with flints." This deposit is formed partly from the small particles of insoluble clay and the flints which have remained after the soluble surface chalk has been dissolved away. It is in parts intermingled with other material of a loamy nature known to geologists as plateau loam or plateau brick-earth. In the western part of the

North Downs the clay with flints is by far the more important, and in the eastern part the plateau loam occupies a greater area, but the common term "clay with flints" will here be used for all this superficial deposit upon the chalk plateau.

The clay with flints forms an almost continuous broad band along the top of the dip slope immediately behind the escarpment, but farther down the slope it has been worn away by the streams which once occupied the now dry valleys, and it remains only on the intervening ridges. In some parts it continues down the dip slope along these ridges until the chalk plateau merges into the London Basin, but elsewhere, as in the South Foreland stow and in central Surrey, the lowest part of the slope is free of the clay. In the bottoms of the dry valleys there are frequently accumulations of the flints, but their gentle slopes have only a thin loamy soil resembling that of the South Downs; the lower and non-clayey part of the dip slope has a similar, but deeper and more productive, loamy soil.

Consequently, among the features of the North Down stows the following are characteristic.

(1) *The escarpment*, facing more or less south-east or south-west and diversified by numerous combes, bears a varied growth of grasses and small herbaceous plants, with bushes and small trees such as the yew, juniper and wild cherry. At the top, on the almost bare chalk, are numerous beech woods; overlooking Dorking is Box Hill, named from its woods of box, another chalk-loving tree, and larch plantations do well and yield useful timber on the same kind of soil.

An early British track, now marked on maps as the Pilgrim's Way or Pilgrim's Road, followed the lower part of the escarpment along much of its length, thus avoiding the ups-and-downs and the forests of the chalk plateau on the one hand and the boggy and still more densely forested Gault-clay hollow on the other.

(2) (a) *The high longitudinal belt*, which is situated behind the escarpment, and (b) *the transverse ridges*, which run down the dip slope between the dry valleys, are covered with the relatively impermeable clay with flints. Consequently these features bear quite a different type of vegetation; woods still occupy much of the land, for the heavy clay is very difficult to work, drying into hard lumps in summer and becoming a sticky mass in winter, while the flints impede the various

agricultural operations. The woods are largely of oak, and the appearance of hornbeam and Spanish chestnut is another indication that the chalk is clay-covered. These woods have a certain economic value, and there are useful plantations of ash and birch. Some of the ground, however, forms almost useless commons, especially where there is sand in the surface deposits; then gorse, broom and bracken cover much of the ground, and foxgloves give bright colour in the summer.

The lower parts of the clay-covered ridges are more utilized than the higher parts of the plateau. Corn crops, especially wheat, and beans are grown, though at the cost of much labour and thorough working and manuring of the soil; consequently the expense of working leads to the abandonment of cultivation in times of agricultural depression, and the areas then become poor pasture lands.

As the soils are to a considerable extent impermeable and hold up the rain-water, there is not the same difficulty in getting a water supply on the higher lands as in the case of the South Downs. Settlements have therefore been established on the ridges as forest-clearings, and there are many ridge roads connecting the settlements and leading up from the London Basin to the escarpment.

(3) *The dry valleys*, with lighter soils and a more protected position, are features more utilized for cultivation, which generally resembles that on the non-clayey lower part of the dip slope. These valleys therefore have farms and farming villages, and the water obtained from wells is in some cases abundant enough to give a supply used by the water companies which have to meet the requirements of the large populations of the adjoining parts of the London Basin.

Directly south of London is the most marked of these dry valleys which, unlike many, does not merely lead up to the escarpment but through a low wind-gap to the Weald. It is therefore an important route from the capital to the South Coast; attention has already been drawn to its influence on the development of Redhill near its southern end, and now it may be pointed out that Croydon, with a population of about a quarter of a million, has grown up at its northern end, while motor transport has caused the older settlements which were dotted along its course to be joined by an almost continuous line of houses in "ribbon development." Very similar conditions

exist in the tributary valley which joins the main one at Purley.

(4) *The lower dip slope*, which is free from the heavy clay with flints and has a thin but relatively fertile covering of loamy soil, is the most productive feature of the chalk plateau stows from the point of view of agriculture, for it has also the advantage of being less exposed than the higher areas and is more closely in touch with the markets afforded by the populous London Basin.

In Surrey, the demand of the metropolis for milk has led to a considerable amount of dairy-farming, together with the growing of vegetables and potatoes for sale. In the eastern part of the tract, sheep farming is more important, and there are areas of open sheep-walks, but here also "cash crops," which are grown for sale rather than use upon the farm, play a large part in the rural economy, and a rotation is employed to serve this end as well as to maintain the fertility of the soil. As an example of this type of rotation may be mentioned a six-year series consisting in successive years of wheat, clover or sainfoin, oats, root-crops, barley and peas. In some parts, this lower dip slope still has an appearance of open rolling grassland rather like that of the South Downs, and the "Epsom Downs" have been utilized as a race-course.

The South Foreland stow, relatively far from the markets for dairy produce but with an easily farmed light and loamy soil, is a region of sheep-walks and arable fields, from which much barley and wheat are obtained. Unlike the adjoining plateau situated on the other side of Watling Street, which is wooded and cut by steep-sided valleys, it is open country with a gently undulating surface, across which ran the part of the "Pilgrim's Road" from the sea near Deal to Canterbury. Where it overlooks the Dover Valley, this part of the chalk plateau is above 400 feet in elevation, but it descends almost uniformly north-eastward, the cliff on which the South Foreland lighthouse is situated being just over 300 feet high, until near Deal and Sandwich it is only a few score feet above sea-level. Although the settlements were largely in the valleys, the easiness of movement and the thorough utilization of the land have led to a network of roads across as well as down the main slope.

The South Foreland stow will probably assume further importance with the development of the "East Kent" or "Dover" coal- and ironfields. Deep below the chalk in the

southern part of this region are deposits of iron ore of workable value, and below this, at depths of between 1,500 feet and 3,000 feet, is a basin of coal-bearing rocks the productive part of which almost coincides with the stow but extends beyond its northern margin along the course of the Stour below Canterbury. A few collieries have begun work in the region, and some coal is obtained, mainly for local use, for the cement and lime works of north Kent and for the Southern Railway. In the future the London demand may be in part met from this area, and with the local ore an iron industry may develop. Whether this development takes place or not will depend upon the costs of production here as compared with those elsewhere, the cost of transport of the products to the main areas of consumption also being taken into account. The southern part of the coal-field has the advantage of nearness to a good harbour, with deep water, in the disused naval base at Dover. It is hoped that in place of the haphazard growth of the older coalfields which often resulted in ugly and unhealthy areas, "town-planning" will here be carried out; the district has been mapped to provide zones of factories, graded according to their "offensive" character, away from the residential quarters, with appropriate provision of parks, open spaces and an agricultural belt.

Valley Stows of the North Downs.—The valleys of the rivers which cross the North Downs lie at a higher level than those of the South Downs; they are generally floored with "valley brick-earth" and recent alluvium, are not marshy and repay cultivation. Moreover, settlements have spread along them from the towns which mark their northern exits, and they carry much more traffic than the South Down valleys; in some cases small industries using the water of the streams are carried on in the villages of these stows.

Settlements of the North Downs.—Only two towns can be regarded as definitely belonging to the chalk tract: Guildford and Dover. Guildford developed upon the chalk on the northern side of the short gap formed by the Wey, at a nodal point of roads which unite all parts of Surrey; it therefore became the administrative centre of that county. Dover has a great deal of the cross-Channel traffic because the crossing to Calais is the shortest, only 22 miles, the French coast being clearly seen in fine weather. Moreover, the break in the line of chalk cliffs which is made by the Dover stream provides good

harbourage, and the road up the valley was an easy one leading across the Downs to Canterbury and thence to London and the rest of the British Isles, though the "boat-trains" from Dover to London now go *via* Folkestone and Ashford on the south side of the North Downs.

Where the northern edge of the chalk outcrop dips beneath the clays and sands of the London Basin (see Figs. 7 and 9), a line of settlements has grown up, taking advantage of the contrasted resources of the different soils; these settlements are joined together by roads which follow fairly closely the margin of the chalk. In many cases the nucleus of the settlement was originally at some convenient place on the dry chalk, but the villages, and particularly the towns, have grown towards each other along the connecting roads and also outwards both up on the chalk and down into the London Basin. Consequently this band of settlement masks the natural distinction between the two regions, and the problem then arises as to whether the marginal area of settlement is to be regarded as belonging to the chalk or to the London Basin. Since, however, the value of marking out geographical regions lies largely in helping to understand the way in which the phenomena affect one another, and since the growth of the settlements is much more closely connected with the work and life of the London Basin than with that of the North Downs, it is with the former that this settlement belt will be studied.

The natural boundary between the two regions is sometimes fairly clear, as in western Surrey where an almost continuous sheet of sands and clay covers the chalk and a line can be drawn along their junction. Elsewhere, as in central Kent, patches of sand lie irregularly over the lower part of the chalk dip slope, and the outwash from these sands over the chalk makes the actual difference between the soils even less clear than the geological map suggests; therefore no definite line can be drawn to limit the regions accurately. There is thus a transitional area, a frontier zone rather than a boundary line, and one which naturally has a rather nondescript character. Such is frequently the case when regions meet on fairly level ground, and it must be realized that boundaries indicated on the maps showing the geographical regions are merely approximate; nevertheless, the characteristics of the country on either side of the transitional area are clear enough, and repay separate examination.

The development of the London Basin has, as it were, drawn this frontier zone of the chalk country into its own sphere of influence, and it has also affected the chalk region itself. This was shown in connexion with the type of farming on the chalk and the ribbon development along the valleys. Also, on the North Downs near London many settlements have been made by people getting their living from the metropolis but desiring the high and healthy situation of the chalk plateau for their homes ; consequently even the ridge of the escarpment in eastern Surrey and western Kent is dotted with their houses, particularly near railways and motor roads.

CHAPTER III

THE LONDON BASIN

IN studying the tract known as the London Basin, it is a help to realize in the first place the general way in which the various soils are arranged, for the special characteristics of these soils are very important in affecting the settlements and the uses to which the land is put ; we shall see that in the London Basin the stows are distinguished from one another largely by the factor of the surface conditions.

Structure and Soils.—The chalk mass of the North Downs and of the northern part of the Hampshire Downs dips in a great down-fold or syncline beneath the sands and clays of the London Basin to rise again to the surface in the Chiltern Hills and the East Anglian Heights. The physical features of the London Basin depend in the main on two factors : the first is the nature of the surface deposits, the sands or gravels having

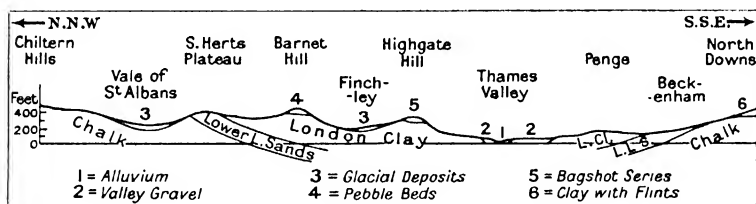
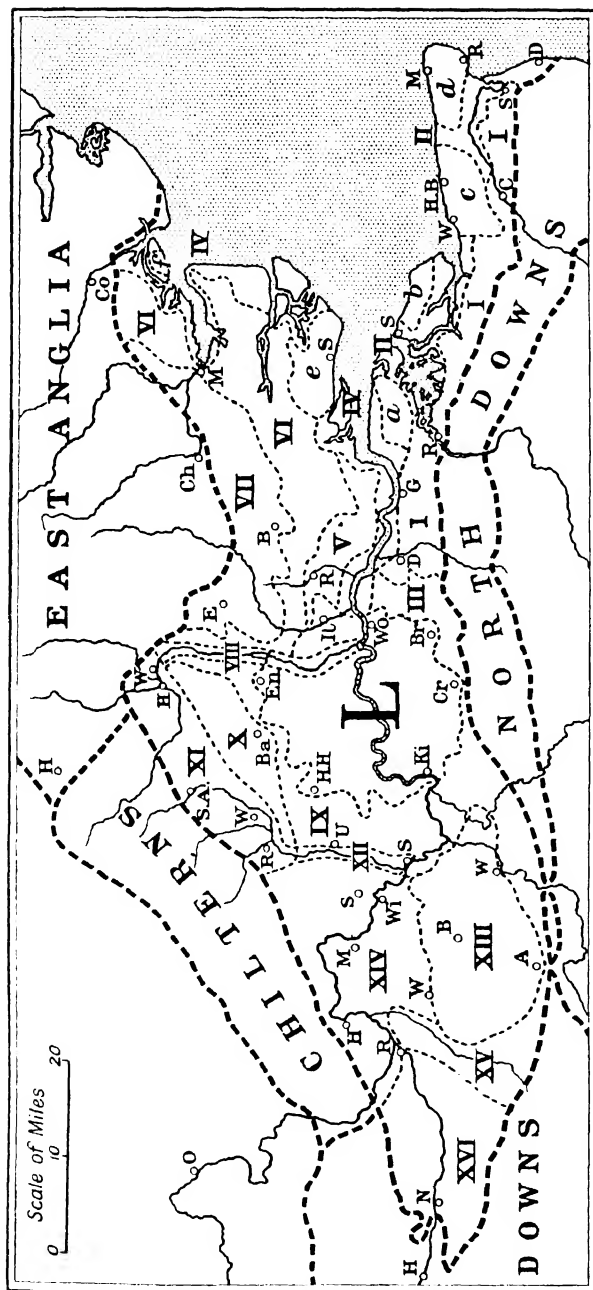


FIG. 11.—SECTION THROUGH THE LONDON BASIN.

very different influences from the clay, and the second is their relative altitude particularly in relation to sea-level. This latter factor is specially important in the east of the region, for a relative depression of the land has caused the sea to invade the lowest areas, and thus brought into existence the group of estuaries of the Thames and the smaller rivers such as the Medway on the south side and the Blackwater and Colne on the north side, while the somewhat higher areas form peninsulas and islands.

Reference to the geological section in Fig. 11 and the map



[Adapted from S. W. Woodbridge.

FIG. 13.—CONSTITUENT REGIONS OF THE LONDON BASIN.

I. North Kent Loam Belt. II. Kent Estuary Belt. III. Chislehurst Plateau. IV. Essex Estuary Belt. V. Essex Gravel Ridge. VI. South Essex Clay Plain. VII. South Essex Hill-lands. VIII. Lea Valley. IX. West London Marginal Belt. X. South Herts Plateau. XI. Vale of St. Albans. XII. Colne Valley. XIII. Bagsshot Heath Region. XIV. Thames Loop Area. XV. Loddon Valley. XVI. Kennet Valley. L indicates the London conurbation.

in Fig. 12, shows that immediately above the chalk lies a series of sandy or pebbly beds, here called the lower London sands,¹ which outcrop on the edge of the London Basin everywhere except in Essex. They are especially important in two districts. The first is in the south-east, where the sands contribute greatly to the existence of the region described presently as the North Kent Loam Belt. (Compare the geological map in Fig. 12 with the map of constituent regions of the London Basin in Fig. 13, and observe the occurrence of the London sands in the Region marked I.) The second area adjoins this belt west of the River Darent, and is here called the Chislehurst Plateau (Region III); it is largely formed of beds of sand, gravel and pebbles.

Above the lower London beds is the thicker sheet of London clay, which reaches over 400 feet in depth and forms the surface of a considerable part of the Basin; it is particularly marked where it underlies practically the whole of the flat South Essex Clay Plain (Region VI), a considerable part of London itself and of the low West London Marginal Belt (Region IX) in Middlesex and Surrey, and much of the valley of the Loddon tributary of the Thames (Region XV).

Above the London clay lies another series of deposits, sands for the most part, which may be grouped under the name of the Bagshot Series, for one important bed of this series forms the surface of the area of heaths and commons (Region XIII) which is situated round the village of Bagshot and overlaps the borders of Surrey, Berkshire and Hampshire. Farther west also, on both sides of the valley of the Kennet tributary of the Thames (Region XVI), there are outcrops of the Bagshot sands.

Still another series of coarse-material deposits is found north-west of London (in Region X) on the southern borders of Hertfordshire, where "pebble-gravel" caps hilly areas rising over 400 feet above sea-level; Bushey Heath is one place, with a significant name, which marks the occurrence of this pebble-gravel. (See the geological map of the London District in Fig. 17.)

Broadly speaking, the preceding beds were deposited in shallow seas or estuaries which once occupied the site of the London Basin, but other formations are of much more recent origin and have been laid down since the region assumed some-

¹ These comprise the Thanet, Reading, Woolwich and Oldhaven Beds, the last including the Blackheath Beds.

thing of its present character. Among these are the river gravels deposited by the main river and its tributaries when the streams flowed at a higher level than they do now. Some of these gravels are found at an elevation of more than 100 feet above the present sea-level, but others were deposited later when the rivers had cut down to a level nearer the present one. Consequently there are broad terraces of gravels and sands situated on the sides of the main valleys, and also still wider sheets spreading out over the lower lands. As an example of the latter may be noted the Thames Valley gravels in the West London Marginal Belt (Region IX).

An important group of the terrace type is situated on the northern bank of the Thames, lower down its course both in London itself and in the adjoining part of Essex. The western part of this particular gravel terrace was an important factor in the origin and development of London, and is to be regarded as the nucleus of the great city, but the eastern part has not been incorporated into the metropolis and remains as a separate region called the Essex Gravel Ledge (Region V). In some areas a loamy brick-earth was deposited as a flood-time silt upon the gravels and also upon some of the clays; this brick-earth modifies the dryness of the gravels and the wetness of the clays, adds greatly to their fertility, and has therefore facilitated their utilization by man. This is notably the case in the terrace north of the Thames, both in London and in Essex, where a fertile loamy soil covers the gravel.

Even later in their formation than the gravels are the muds which the Thames and its tributaries have laid down in their flood-plains; these alluvial soils characterize the regions of the Colne valley (Region XII), the Lea valley (Region VIII) and the lowest-lying areas of the Thames estuary (Regions II and IV). Were it not for embankments, the rivers would still add to these deposits in times of floods and at high tides.

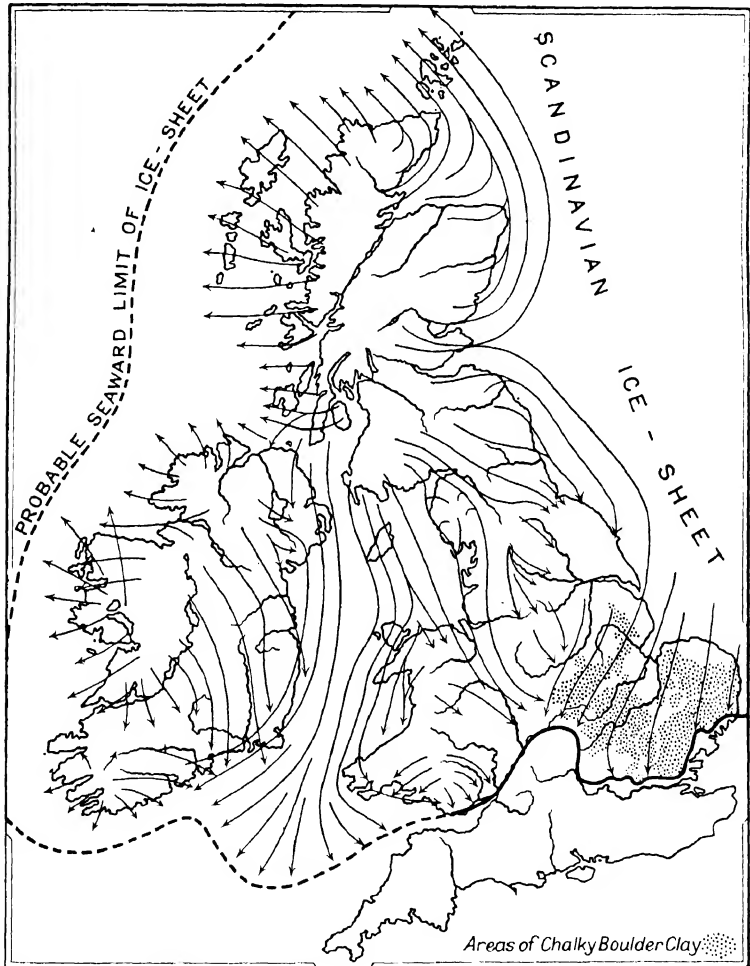
The question now arises: How are the limits of the London Basin to be determined? The southern boundary of the London Basin is formed by the outcrop of the chalk of the North Downs and the Hampshire Downs, while the north-western boundary is similarly formed by the chalk of the Chiltern Hills, but in the north-east the limit is set not by the "solid" geology of the chalk-sheet but by the occurrence of the "drift" formation of the glacial "boulder clay." This glacial

deposit was formed in the last Ice Age when the ice-sheet from the north overrode the chalk East Anglian Heights, scouring their surface, and pressed on into the lower land of northern Essex till it was melted by the increasing warmth of the south. (See the map of glaciation in Fig. 14.) Below the ice-sheet was accumulated material of various nature, known commonly as boulder clay since it often contains large boulders mixed with finer matter, some of the material having been brought for hundreds of miles and some of it being derived from the soils of the immediate neighbourhood. In front of the edge of the ice-sheet the melted ice-water washed out the smaller material, and glacial gravels are found beyond the margin of the boulder clay. But as the climate became warmer with the passing of the Ice Age, the edge of the ice-sheet retreated, i.e. occupied progressively a more northerly position, and the out-wash gravels were deposited on top of the boulder clay. Moreover, there were, within the Ice Age, several periods of excessive cold when the ice-sheet advanced over its former margin, and then boulder clay was deposited above the earlier glacial gravels of the former out-wash area. Also, later river action has worn away and redeposited part of the glacial material. Consequently the geological distributions are very complicated, as appears in the map in Fig. 12, and the limits of the boulder clay and of the glacial gravels are not always sharply defined.

Yet it is broadly true that in northern Essex the soils and surface conditions are determined by the former extension of the ice, and the consequent deposition of a sheet of boulder clay; this has such marked results in the geography that a new geographical region is indicated, since this northern part of Essex has much more in common with the glaciated East Anglia to the north than with the London Basin to the south. Again compare the maps in Figs. 12 and 13, and note that over the region marked out as East Anglia, the geological formations are shown almost everywhere as of boulder clay or glacial gravel.

Even within the London Basin some effect of the Ice Age is to be seen, for there are small patches of the boulder clay and accumulations of glacial gravels lying on the older formations beyond the limit of the line drawn on the map as the boundary of the East Anglian Region. In the marginal part of the London Basin called the South Essex Hill-lands (Region VII), there are

areas of so-called boulder clay, but this is to a considerable degree formed of London clay which was pushed forward a little way by the extreme edge of the ice, and in its geographical conse-



[After W. B. Wright and S. F. Wood.]

FIG. 14.—GLACIATED AREAS OF THE BRITISH ISLES.

The arrows show the directions of the ice-flow.

quences is not markedly different from the untouched London clay. In the same region there are also deposits of glacial gravels.

A second area in the London Basin in which glacial materials must be taken into account is in the Vale of St. Albans (Region XI), for patches of boulder clay and wider expanses of glacial gravels have extended down this hollow from the main ice-sheet. Also, a patch of boulder clay lying on glacial gravels forms the area on which is built Finchley, a suburb of north-west London. (See the geological map of the London District in Fig. 17 and section in Fig. 11.) This boulder clay contains some chalky material but also much London clay. Glacial gravels, too, cover the adjoining hilly district of Hendon in the North London area, and even in the South London area there are patches in Richmond Park, on Kingston Hill, and on Putney Heath and Wimbledon Common. Thus certain glacial deposits must be included in the materials which have gone to the formation of the surface of the London Basin; nevertheless, glaciation may be taken as the distinguishing factor between this tract and the East Anglian region to the north-east.

It was stated above that the physical features of the London Basin depend partly on the nature of the several surface deposits of clays, gravels, sands and muds which have now been described, and partly upon their relative altitude. Both the distribution of these deposits and their altitude have themselves been largely determined by minor warpings and by faultings, i.e. cracks, in the earth's crust which have occurred within the great syncline or downfold of the basin. For example, on the south side of the Thames Estuary an anticline running in an east-west direction near Gravesend has brought up the chalk so that it forms the surface at Gravesend and on both sides of it, and a little farther up-stream at Purfleet the chalk appears even on the north side of the river. Consequently there is firm ground, giving useful landing-places, where the river has cut into the chalk mass at Purfleet on the one side and a few miles lower down at Gravesend on the other side.

To the south-east of this upfold there is a downfold which has led to the sea invading the relative hollow in the estuary of the Medway between Sheerness and Rochester, so that on the west side of this estuary there is a peninsula between the Thames and Medway, and on the east side there is the Isle of Sheppey; also, while the central part of the peninsula (the "Hundred of Hoo," Region II*a*) is formed of chalk, London clay and gravels, and the Isle of Sheppey (Region II*b*) is mainly of London clay

and gravels, the low shores of the Medway estuary are of recent alluvium.

Another example of the warpings is found still farther eastward, where an anticline has brought up the chalk to form the surface of the Isle of Thanet (Region II*d*). This area was indeed once an island separated from the mainland by a channel known as the Wantsum; through this channel the small ships of Roman times reached the Stour, which was then navigable to Canterbury, and they also used the Wantsum to enter the Thames mouth without passing round Thanet. The Wantsum is now silted up and the Stour meanders in extraordinary convolutions through its marshy levels to reach the Strait of Dover.

These east-west folds are parallel to the main direction of the great Wealden anticline which they adjoin, while another set, north-west of London, correspond with the general trend of the Chilterns. Thus an anticline appears near Windsor and can be followed to the north-east, parallel to the edge of the chalk, through an area of high ground which forms the south-eastern boundary of the Vale of St. Albans and is called the South Herts Plateau (Region X). At Windsor the upfold has brought the chalk to the surface through the covering of London clay and sands, and this chalk "inlier" forms the hill on which Windsor Castle is built overlooking the Thames.

A third direction of these minor dislocations of the London Basin is north-south, and this is shown by two folds which have facilitated the erosion of the layers along the north-south lines of the Lea and the Colne before they enter the Thames, and thus led to the development of the broad flood-plains of these rivers.

These examples show how a knowledge of the structure of the earth's surface may reveal a pattern in what would otherwise be a meaningless jumble of surface features, and thus enable the geographical facts to be correlated and more easily remembered.

Climate of the London Basin.—The climate is more "continental" than that of regions nearer the South Coast. The south-west winds from the Atlantic have already crossed higher ground, and precipitate relatively little rain in this lower country, the mean annual rainfall being about 25 inches for London and only about 20 inches on the flat shores of the Thames estuary; its distribution through the year is shown in the graph

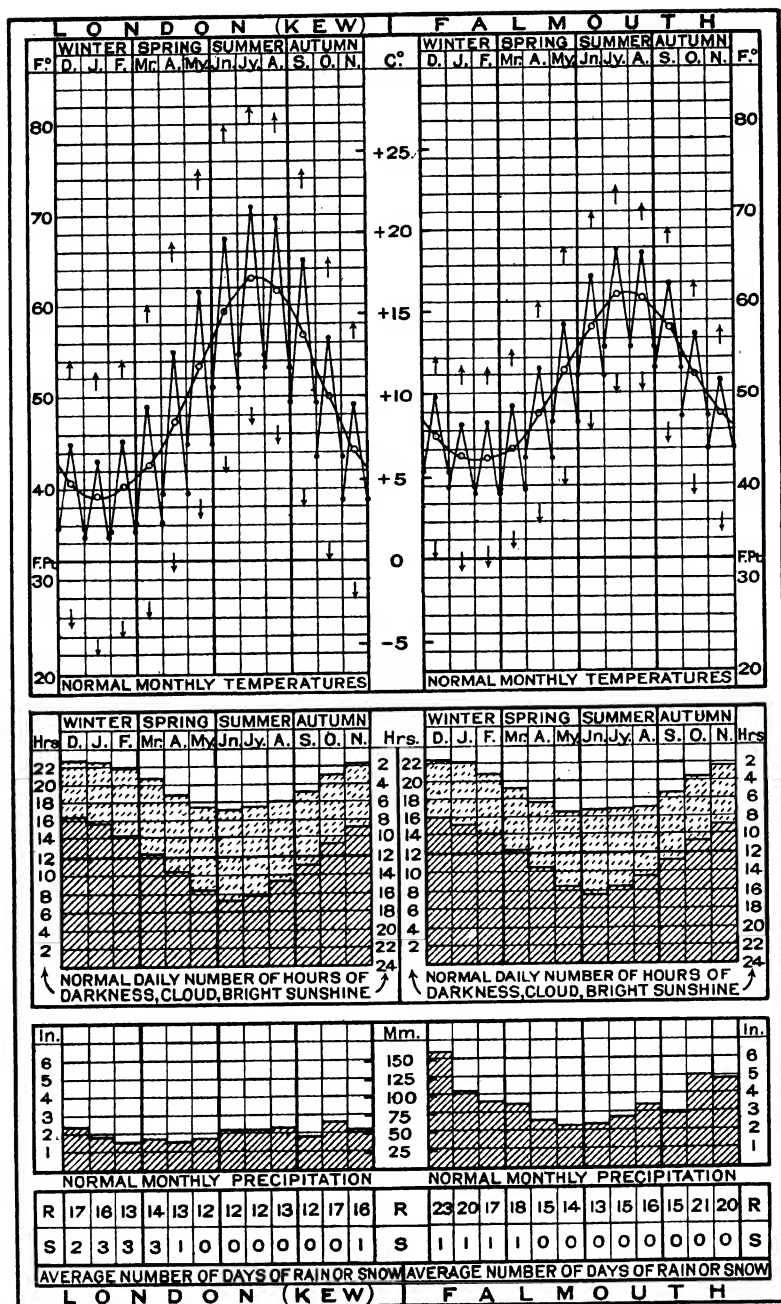


FIG. 15.—GRAPHS OF CLIMATE AT LONDON AND FALMOUTH.

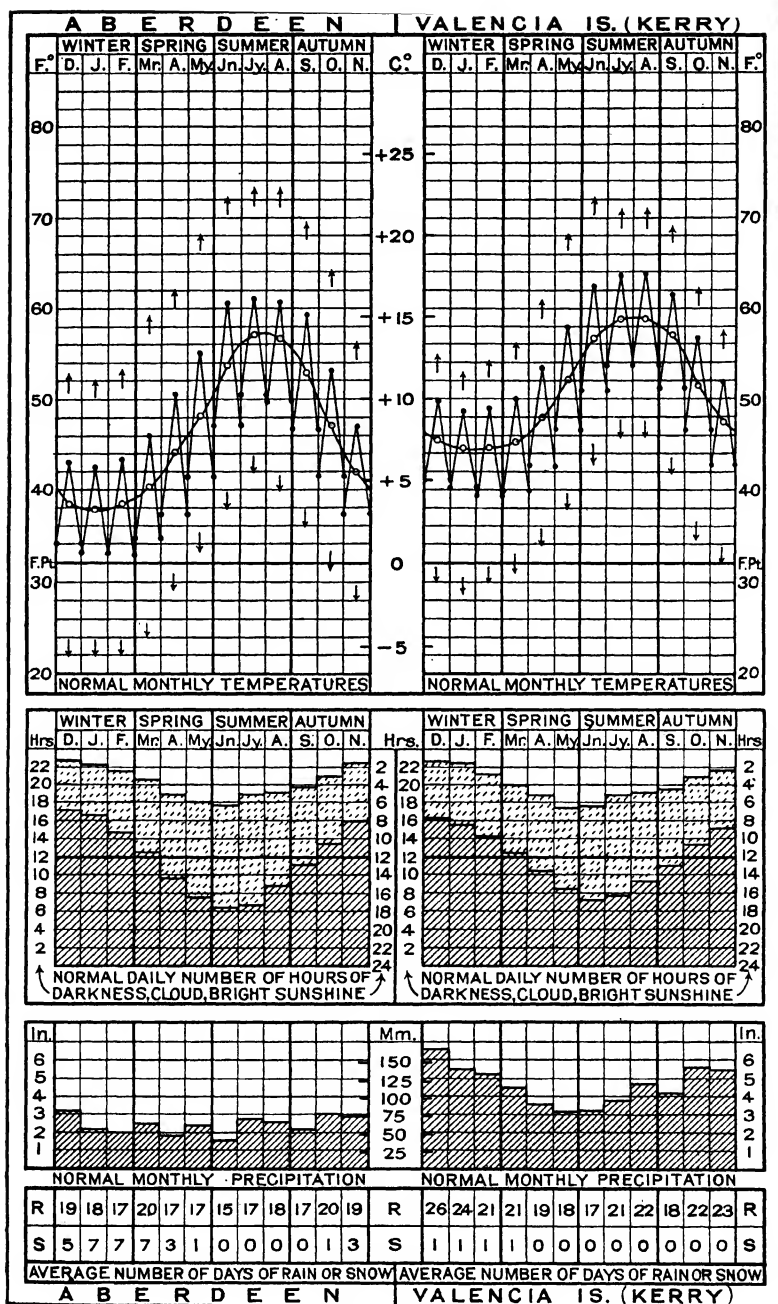


FIG. 16.—GRAPHS OF CLIMATE AT ABERDEEN AND VALENCIA IS.

in Fig. 15, from which it is seen that a fair amount falls at all seasons, the maximum being in October.

Temperatures are somewhat more extreme than along the South Coast ; in summer, the south-east of England, adjoining the continent, has a higher average than any other part of the British Isles, partly owing to its proximity to the great heated land-mass of Europe and partly owing to its southerly latitude. The isothermal map for July shows that the highest temperatures, giving an average of nearly 64° Fahr., are reached in the London district. On the contrary, in winter the temperatures near the eastern coasts are the lowest of those experienced on the lowlands of Britain, as the heat at this season is derived from the westerly Atlantic winds rather than from the sun which then gives relatively little heat, while the easterly and north-easterly winds to which this part of Britain is most exposed reduce the temperature considerably. The isothermal map for January shows that East Anglia is one of several areas with a sea-level temperature of less than 38° Fahr., and the London Basin is but little warmer. The mean annual range of temperature in London is therefore about 24° Fahr., and Figs. 15 and 16 should be examined to see how this range compares with that at other British stations. The wide daily range, especially marked in summer, should also be observed.

From the point of view of the human geography, the differences between the winter conditions are of less significance than the differences in summer, when the high temperatures and low rainfall, with the accompanying absence of cloud, in the ripening season of corn and fruits are a great advantage to the areas around the Lower Thames as well as to the Eastern Counties.

Constituent Areas of the London Basin.—After this general introduction, the synthetic study of the region may now be pursued. It is obviously a tract consisting of a number of stows, which in the main are distinguished from one another by the soils which underlie them. Space does not permit of separate treatment of every stow, and in some cases a few adjoining stows, which are closely related to each other, are considered together.

In the first place, it may be noticed that certain relatively large areas stand out clearly because of their situation and character. The Thames estuary makes a natural division between the Kentish areas on the south side and the Essex areas

on the north side, while at the head of the estuary a third region is formed by the great conurbation¹ of London. This has spread so widely that it practically reaches the North Downs on the one side, separating the more open country of Kent from that of Surrey, and on the other side it similarly divides the Essex area from that of Middlesex.

In order to facilitate the local government, the "administrative county of London" was formed out of the portions of the adjoining older counties over which the settlement had extended, but the conurbation as shown on the map has now expanded beyond the limits of the new county of London, and its outlying portions fall within the borders of Middlesex, Essex, Surrey and Kent.

This great built-over area has been so transformed by man's direct action that in many ways it is quite unlike what it was in a natural condition and its geographical significance now lies in its human activities. London must be studied apart from neighbouring areas even though it is closely related to them; consequently it is regarded as a separate stow.

North-west and west of London is a fourth area of the London Basin, and here, as in the case of the eastern areas, physical characteristics are still the decisive factors in determining the general character of the country.

The North Kent Areas.—At the close of the section on the North Downs, it was pointed out that on the margin of the chalk tract a fertile mixture of surface deposits, together with a favourable situation for settlement and communication, had allowed the development of a productive and populous belt of country; this area may be regarded as a group of stows of very similar character, and termed the *North Kent Loam Belt*. Sands of the lower London series form the predominating part of the soils, but these also include areas of the chalk and the clay with flints, patches of the London clay, and deposits of brick-earth; natural and artificial mixing of these materials has resulted in widespread loamy soils of exceptional fertility. Orchards, particularly of cherry trees grown among grass on which sheep feed, characterize the central and western parts whence transport to the London market is cheap and rapid; hop gardens are found more to the east; and everywhere fruit—

¹ Professor Fawcett has used this useful term to indicate an area of continuous urban settlement, formed of one or more than one administrative unit.

strawberries, currants, etc.—and vegetables are grown for sale and for home consumption.

The North Kent Loam Belt, besides its horticulture and agriculture, has resources which are largely due to its situation. The chalk tracts of England cover great areas, but the chalk is used for industrial purposes only when the situation allows easy transport. In this North Kent belt, although the chalk outcrops in relatively small amount, it does so in places where the upfolds have brought it to the surface in close proximity to navigable waterways ; thus near Gravesend on the Thames and near Rochester on the Medway it is quarried and utilized in great lime and cement works which give occupation to some thousands of people.

The importance of the commercial situation of this region has already been suggested in connexion with the route connecting the Continent by way of Dover and Canterbury with the metropolis. Where this route from the Continent crossed the first river, the once navigable Stour, arose Canterbury, which became the see of the Primate of All England, the site of the first English cathedral and the scene of many historical occurrences. The silting-up of the Stour and the distance of Canterbury from the metropolis have, however, not allowed a commercial development. At Rochester, by the next crossing on the road to London, that of the Medway, the see of another bishopric was established and a great castle was built. Here the estuary of the river gave, and still gives, access from the sea ; consequently a group of towns, of which Rochester, Chatham, Gillingham and Strood are the largest, has grown into a conurbation of considerable size. Chatham is well known for its naval dockyard, and engineering of various kinds is carried on, while the making of agricultural tractors and other farming requisites has the advantage of a large local market as well as easy transport of raw materials. Oil-refining also finds an economical situation in the same neighbourhood.

The route to London skirts the Thames itself at Gravesend, where the London pilots board and leave the ships. At the next crossing place, that of the Darent, grew up Dartford, where the stream had to be forded in the days before it was bridged.

Throughout the loam belt, firm ground and easily obtained water favour the growth of numerous towns and villages, and at its eastern end, where it abuts upon the Strait of Dover, are

situated the old port of Sandwich, now silted up, and Deal, which can still be used by small vessels.

Between this belt and the Thames (save at the one place near Gravesend) is a low-lying area, the *Kent Estuary Belt*, which consists of more than one type of country as will be explained ; it is a stow-group rather than a single stow. It is largely marsh land which is marked on the geological map as of alluvial formation. This marshy region is of relatively little value, but now that it has been embanked it affords good grazing ground ; many animals are to be seen upon it, but few people and very few settlements. Sheerness is an exception ; it was built as a fort and later developed as a dockyard at a point where it could defend the entrances both to the Medway and to the Thames. Where the marshes reach the Thames estuary, wide stretches of mud are exposed at low water beyond the embankments.

In four places, however, these marshes are interrupted by areas of higher and firmer ground which have agricultural value and are the sites of villages and even towns. (a) Between the Medway and Thames estuaries is the "Hundred of Hoo," which may be regarded as an extension of the loam belt but is situated off the main line of communication and is therefore less developed. (b) Cut off from the mainland by the Medway estuary and the shallow channel known as the Swale is the Isle of Sheppey, whose frontage to the Thames is partly formed by low clay cliffs. (c) Between the Swale channel and the Wantsum marsh, "Blean" is an area of firm ground, clayey and sandy, which reaches the sea beyond the Thames estuary and has two seaside resorts for Londoners, Herne Bay and Whitstable, the latter being noted for the oyster beds of the adjoining shallow waters.

Finally, (d) the Isle of Thanet is formed by the upfold of chalk whose cliffs stand out to the North Sea in the promontory of the North Foreland. As on the chalk has developed a light loamy soil, the area is well farmed and has a considerable acreage under barley. It also produces much hay from sainfoin and lucerne, crops which can survive the dry conditions due to the combined influences of the soil, the relatively low rainfall and the strong winds from the north and east. Round its shores are a number of resorts, e.g. Margate on the north and Ramsgate on the south, which, like those of the east coast of Britain in general, offer more bracing holidays than those of the southern and western shores. The Isle of Thanet clearly stands out from its immediate sur-

roundings as a separate stow ; moreover, it resembles the South Foreland stow in structure, in soil conditions and in the utilization of the land. It may therefore be regarded as a detached portion, an "exclave," of the North Downs tract, although by situation it is part of the London Basin.

West of the Darent Valley, the North Kent Loam Belt gives way to a region of more marked relief which may be considered as another stow and is called the *Chislehurst Plateau*. It is formed largely of gravel deposits to which geologists have given the name "Blackheath Beds," but Blackheath itself is now part of the London stow. Much of the plateau has been reduced by erosion to a series of ridges and hills, and in parts the surface is formed of clay which is more easily worn down than the sands and gravels. The area is highest in the south where it attains an elevation of over 400 feet. As a whole, the Chislehurst Plateau is rather infertile and considerable areas remain as commons, but settlements are extending out from London, especially in the lower northern part and along the railways, for some of the lower parts have mixed soils and are used for market gardening, while the higher ground in the neighbourhood of the open commons attracts residents.

The South Essex Area.—Bordering the Thames on the north side is the *Essex Estuary Belt*, a stow-group which in several ways resembles the Kent Estuary Belt. It is in general low-lying and much of it is marsh-land of alluvial formation, while there are certain patches of firmer ground.

Below the London Docks the north bank of the river is swampy, but at Dagenham a factory district is being developed, at the cost of dyking, draining and the construction of the buildings upon a foundation of piles driven down through the alluvium ; the site has the advantage of proximity to London and easy and cheap water transport for its raw materials and the export of its products. Here are great motor works which are more than assembly-shops, for there are even coke ovens and a blast furnace for the making of the steel. Oil is landed and stored in these extensive flats, and there are great oil refineries at Thames Haven and Shell Haven between the Tilbury Docks (opposite Gravesend) and Canvey Island (opposite the Hundred of Hoo).

Apart from such commercial and industrial development, the main use of the alluvial areas is for grazing horses, sheep and

cattle ; there is one wide belt of rich pasture-land on and behind Canvey Island. Another wide area extends behind the east coast between Shoeburyness and the estuary of the Blackwater and Chalmer, where the country bears a marked resemblance to the Romney Marsh region, though cattle as well as sheep are bred in these Essex flats. In this salt-marsh area there are great stretches of mud and sand exposed at low water beyond the sea-wall.

There is, of course, little settlement on the alluvial areas, though in recent years many bungalows have been built on Canvey Island, while the series of estuaries which run in a general east-west direction, e.g. those of the Crouch and Blackwater, are utilized for yachting, fowling and fishing.

As in the Kent Estuary Belt, so here in the Essex Estuary Belt there are areas of firmer ground rising out of the marshes. Thus north of the Blackwater estuary there is *Mersea Island* (f), with farm land attaining an elevation of about 70 feet above sea-level. A much more important region of this kind is the *Southend Plateau* (e) ; this is low in the east where it is formed of brick-earth and gravel of the river-terrace series, and becomes gradually higher towards the west where London clay appears and there are hills capped with the Bagshot Beds. Farms and woods cover these higher portions, but the more level, plateau-like stretch with low cliffs overlooking the estuary has been almost completely built over. "Leigh-on-Sea," "Southend-on-Sea," and smaller settlements have grown rapidly in recent years owing to the facts that the soils give good building foundations and facilitate the provision of water supply and drainage, while Londoners can get to the end of the Thames Estuary more quickly and cheaply than to the other "seaside suburbs" of the metropolis, the distance from London being little over 40 miles ; many people live there and travel daily to their work in the City.

Immediately behind the flood-plain of the Thames below London stands the *South Essex Gravel Ledge*. The name of this stow might be somewhat misleading if it were not realized that above the gravel there are considerable areas of loamy brick-earth that add to its fertility. The minor upfold that was referred to in a preceding section brings chalk to the surface and thus adds to the variety of its resources, leading to the existence of lime and cement works at Purfleet and Grays, where this ledge is reached by two northward meanders of the river in its flood-plain. Near London the ledge has been much

utilized for market gardens, and the buildings of the metropolis are gradually extending over it. One of the great Roman roads was built from London north-eastward into East Anglia, crossing two of the small rivers of this belt of country at Ilford on the Roding and Romford on the Rom respectively ; the former town is now part of the great conurbation, but the latter is situated farther to the north-east on the margin of the gravel ledge. (The beginning of this route is marked 2 on the map of the London District in Fig. 18.)

The South Essex Clay Plain is a stow of less significance from the point of view of human geography. The London clay which forms its surface is, here as elsewhere, inimical to settlement and difficult to cultivate. It long remained a forest and is now largely grassland, dairy produce being produced in the west for the London market and in the east for the Southend area. The clay surface has been worn remarkably level, almost the only features in the relief being due to patches of gravel lying above the clay. The population is small and is scattered widely in isolated farms and in villages ; there are no towns of any size in the area.

The South Essex Hill-lands are, as the name is intended to suggest, a region of irregular relief ; much of it lies between 200 and 300 feet above sea-level, but the streams which cross it have cut their valleys considerably below this general elevation. The soil conditions are almost as irregular as the relief ; London clay is exposed in some parts, especially in the river valleys, and the chalky boulder clay covers other parts, while glacial sands and gravels are found fairly widely distributed and form the surface of the greater part of the north-eastern extension of the region. There is also a marked diversity in the vegetation cover and the utilization of the land. The ridges are in part still forested, and Epping Forest on the western margin is a playground for Londoners ; in some of the river valleys, as in that of the Roding east of the Epping Forest Ridge (see Fig. 18), there are water-meadows yielding rich crops of hay ; there is also a considerable proportion of arable land, especially where the soils are of the mixed or loamy type ; there are fairly wide stretches of heathland, particularly in the hilly districts of glacial gravel west and north of Maldon, though in the latter country, near Tiptree, a successful jam factory has encouraged the growing of fruit in its vicinity.

Settlements and small towns are fairly numerous. Epping was a stage along the road which followed the ridge leading northward between the Lea and Roding valleys; Brentwood grew up where the Roman road emerged from the clay plain upon this higher and drier land; Maldon is situated where a hill of glacial gravel overlooks the head of the Blackwater estuary. In their soil conditions, and the consequent land utilization, the South Essex Hill-lands are to be regarded as a transition area between the London Basin and the glaciated East Anglian region.

The *Lea Valley*, in its north-south reach below Ware, is a wide marshy hollow, liable to flood; this characteristic made it a natural division between settlements on the higher lands on either hand, and for that reason the River Lea was adopted as the western boundary of the county of Essex. Consequently here, on a small scale, is an example of what is often found on a larger scale: a river is taken as an administrative boundary or a political frontier even though it flows through a district with similar conditions on both banks, and thus arises one case of a discrepancy between political and natural regions.

In the lowest part of its course the River Lea was adopted as the eastern boundary of the new administrative county of London, but the conurbation has spread across to the eastern side of the valley, and the factories and houses have been built even in the recently drained marshy hollow itself. The course of the river has been regulated: large reservoirs have been constructed for the water supply (see the maps on a larger scale in Figs. 17 and 18), and for communications a relatively straight channel known as the River Lea Navigation is maintained west of the meandering stream. This "Navigation" is utilized as far as the Enfield Lock for the carriage of large amounts of heavy goods, mainly timber, coal and coke, and as far as Enfield factories have spread up the valley, employing for transport the "Navigation," the railway and the motor roads which have also followed the west side of the stream.

In this part of the valley, large stretches of land hitherto practically useless have been turned into railway sidings, parks and playing fields. Thus the lowest part of the Lea Valley has been so transformed by human agency that it is most conveniently regarded as a part of London. It no longer stands out from the surrounding area as a clearly defined unit which may

be separately studied, for its life is essentially bound up with that of the metropolis, and it may therefore be considered as one of the most clearly marked "features" of the London stow.

Above this lowest, metropolitan part of the Lea Valley, its most important utilization is due to a terrace of loamy brick-earth which occupies the west side of the valley. On this terrace the Roman road known as Ermine Street ran from London northward, avoiding the marshy alluvium of the Lea Valley on the one side and the sticky London clay on the other (Road 3 in Fig. 18). In recent years the brick-earth has proved a fertile soil for an important nursery industry; there are about 1,400 acres under glass (approximately half the total amount of all Britain), producing tomatoes, cucumbers, flowers and even grapes for the London market. The brick-making of earlier years has now almost ceased with the practical exhaustion of the best and most conveniently situated supplies of brick-earth. Small manufacturing industries exist at certain centres, and following the recent construction of motor roads along this western side of the valley to link London with north-eastern England, there will probably be an increase in this industrial work within the region, and an encroachment of the metropolis into its northern portion.

The Western Areas.—The London stow is so important that its study demands a separate chapter; we will therefore leave it till later and now proceed to consider the western part of the London Basin.

Immediately surrounding London on the north and west is a belt of country which is in process of assimilation by the metropolis and may be called the *West London Marginal Belt*. Its surface is largely of London clay, except in the neighbourhood of the Thames and its tributary the Mole, where there are river-terrace gravels and Bagshot sands. As in the eastern parts of the London Basin, while on the gravels there are heaths, the clays have been largely utilized as pasture lands. Recently, however, along the lines of road and rail communication the farms are being abandoned to builders, and on the gravel areas the open lands and the large estates of the gentry are giving place to residential suburbs of Londoners. The modern trunk roads to Oxford, Bath and Portsmouth cross this region, the last following a part of the course of the Roman Stane Street leading from London to Chichester. Near the Thames the

gravels are widely covered with fertile brick-earth, and here market-gardening and the nursery industry have been able to maintain themselves. In the same districts are enormous reservoirs from which the greater part of London's water supply is derived.

On its north-western side, London has almost reached the *South Herts Plateau*, the belt of high ground on the southern borders of Hertfordshire.

This stow is a dissected plateau of which the remaining parts lie at a level of about 400 feet above the sea ; these high areas are formed of the pebble-gravel which has protected from erosion the underlying clay exposed upon the slopes. On the heights there are patches of heath ; there are also fairly extensive woods, especially at the north-eastern end ; much of the clayey slopes is still farm-land. The gravel areas are favourable to settlements and these are being extended by residents from London, notably along the lines of two famous old roads (marked 4 and 5 in Fig. 18), the "Great North Road" which leads through Barnet, and the Roman "Watling Street," known as the "Edgware Road" where it leaves central London, which crosses the plateau in the direction of St. Albans. Extensions of the London Underground Railway system have recently followed the courses of these ancient roads, and along them there is now a ribbon-development of building across the marginal belt well into the South Herts Plateau.

This clearly marked stow ends north-westward by an escarpment-like descent into the equally well-marked stow, the *Vale of St. Albans*. In this wide hollow between the Chiltern Hills and the South Herts Plateau were accumulated the glacial clay, sands and gravel, as shown in Fig. 11 above, and to these deposits have been added those brought down from the Chilterns by head-streams of the Lea which flows along the north-eastern end of the Vale, and by the tributaries of the Colne which flows in the reverse direction to the south-western exit. Consequently, the soils of the Vale are of diverse character, and while some parts are rather barren, the greater portion of the surface is of a loamy nature and has well repaid working. The farming is generally of the "mixed" variety, in which the production of grain and other cash crops is balanced by the growing of grass and fodder for animals. A line of settlements is found in the Vale : near the south-western end are Rickmansworth and

Watford where tributaries of the Colne, accompanied by roads, come from the Chiltern valleys to meet the main stream ; near the north-eastern end is Hertford where three streams from the Chilterns and East Anglian Heights meet the Lea and give a natural nodal position for a county town ; at the north-eastern extremity where the Lea turns sharply southward is Ware ; almost in the centre of the region is St. Albans, close by the site of the Roman city of Verulam, which was situated where Watling Street left the Vale to cross the Chilterns by following the valley of the small River Var.

Because of the facilities for communication between the Midlands on the one hand and the metropolis on the other, even this relatively remote region of the London Basin has been invaded, not only by people whose living is directly or indirectly derived from London, but also by small industrial developments ; these changes are particularly marked in the neighbourhood of Watford, long famous for the beer brewed with the clear water of the Colne and with malt made from barley grown on the neighbouring Chiltern Hills.

The *Lower Colne Valley* in some respects resembles the lower Lea valley, for it is a naturally marshy region floored by alluvium ; but the braided channels of the stream have not been so modified as those of the Lea, the Grand Union Canal which follows part of the valley is not so utilized for traffic as the Lea Navigation, there are no great water reservoirs, and no large industrial or residential areas have grown up in the marshy area. Uxbridge is situated on the eastern bank where, at one of the narrower parts of the valley, it is crossed by the main road from London to Oxford, and farther south the Colne valley is crossed by the Bath Road. The Colne valley enters that of the Thames at Staines, the "Stones" where the fourth of the Roman roads, which led from London on the north side of the Thames, crossed the river to reach South-western England.

This Roman road then traversed the northern part of the stow which may be named the *Bagshot Heath Region* ; here sands and gravels underlie a number of "heaths" and "commons" whose relatively sterile soils give rise to stretches of heather and bracken. In some parts iron compounds have cemented the loose sand into a "pan," which is impermeable and holds up the surface water, forming a marshy soil in which such plants as moss, cotton-grass and rushes flourish. Consequently, the

Bagshot Heath region, marked either by exceptionally dry or exceptionally wet conditions, has proved unremunerative for farming, and has to a large extent either remained as common land or, in the case of the dry areas, been utilized as a training ground for the army. Near Bagshot are the Bisley Ranges, and the great military encampment of Aldershot is on the southern border. Other settlements, e.g. Woking and Wokingham, have grown up on the boundary of the gravel beds, where water sinking through them comes out upon the London clay which underlies the gravel and outcrops beyond its margins. Near the northern border, Ascot Race-course has been laid out, while, close by, Windsor Great Park lies partly on the Bagshot Beds and partly on the London clay between the heath country and Windsor Castle.

North of the Bagshot Heath region is an area which, if studied in detail, would have to be subdivided, but may here be treated as a stow-group; it is underlain in part by London clay and in part by gravels, and the most striking feature of this area is the winding course of the Thames which, below Reading, makes a great northward loop past Henley and Maidenhead.

These and other river resorts are thronged in summer by those seeking pleasure by and on the river, for the scenery here is very attractive in a quiet way. Broad meadows on the alluvium are backed by woods on the slopes; some of these slopes are gentle where they are formed on the clay and others rise more steeply to gravel-capped hills or plateaus; in winter floods may cover the meadows and fogs blot out the view of the hills. Between this loop and Staines, Windsor Castle on its chalk hill overlooks both the river and Eton, which is situated on the opposite bank. Most of this "*Thames Loop*" area is pleasant country of fields and woods, but an exception is found in the neighbourhood of Slough, where a large industrial colony has been formed upon the site of munition factories erected during the Great War. When the land and buildings were given up by the Government, a "trading estate" was formed on which manufacturers could find ready-to-hand buildings, a local labour market and good transport facilities. Now many thousands of people are engaged in small industries similar to those of the western and north-western parts of Greater London, and Slough may be regarded as an "exclave" of that region.

West of the Bagshot Heath area is the stow formed by the

broad and shallow *Loddon Valley*, carved by the Loddon stream from the London clay, and still farther west the pointed tip of the London Basin which may be called the *Kennet Valley Region*.

The Kennet rises in chalk country near Marlborough, and at Newbury enters the London Basin, where it receives small tributaries from north and south before it reaches the Thames at Reading. In this westernmost part, the narrow syncline of the chalk is filled in with a sheet of the lower London sands and gravels which are almost covered by the London clay, and this in its turn bears considerable areas of the Bagshot Beds, while the Kennet meanders in a flood-plain of alluvium. Consequently surface conditions vary considerably, and the irrigated water-meadows of the river-side are backed by arable and pasture lands, and behind those again are higher areas on which woods and heaths appear.

The Kennet valley has been an important route-way for many centuries, for it prolongs westward the axis of the London Basin and leads to an easy crossing of the western chalklands and so to Bath and Bristol. Where the "Bath Road" left the Thames valley and crossed the Kennet, the town of Reading arose, and where it left the London Basin and entered the Downs country, Newbury is situated. At both places there are also north-south routes crossing the Bath Road, but during the past century Reading has become by far the larger of the two towns. It is the county town of Berkshire, in which it is almost centrally placed, but the chief reasons for this development of Reading are that it is relatively near to the metropolis, and that it is at the junction of the Bath Road and the main railway route from London to the west which at this point branches north-westward up the Thames Valley through the chalk hills.

In consequence of this favourable commercial situation of Reading, a great biscuit-making enterprise has been able to flourish, a great seed-raising firm has used the levels by the river, and engineering works (partly in connexion with the railway itself) have been established, while a modern University has been assisted to develop by the prosperous manufacturers and traders of the town. The influence of London is also to be perceived in this westernmost part of the Basin in the fact that the fast railway service is making the Reading district one of the "dormitories" of the metropolis.

CHAPTER IV

LONDON

IN studying the relation of a human settlement to its environment, a distinction may be drawn between its *site*, i.e. the particular area on which it is built, and its *position*, i.e. its general situation as regards surrounding regions and the ways of communication.

The *site* of the original settlement of London, now occupied by the "City," was the gravel terrace which lies about 50 feet above the flood-plain on the northern bank of the Thames. This terrace had been cut into by small tributaries whose waters have since been taken into underground sewers, but whose names are commemorated in the present thoroughfares "Walbrook" and "Fleet" Street. As a result of this erosion, two defensible hills stood up above the river, and these gave good building sites and had an adequate water supply in the mass of gravel. On the down-stream side, facing the river from which attacks might come, was built the Tower of London.

While this site provided opportunity for a settlement, it was the *position* that enabled that settlement to grow great. It has already been pointed out that along the North Kent Loam Belt lay the best route from the Continent to Britain, but this route actually skirted the Thames only at Gravesend. Opposite Gravesend, however, there is, on the Essex bank, a broad stretch of alluvium which in early times, before embanking and draining, was a marsh periodically flooded. Crossing at this point would have been always difficult and sometimes impossible. Farther upstream the Chislehurst Plateau directly overlooks the Thames at Erith and Woolwich, but here again on the northern side of the river is a wide stretch of alluvium. Therefore, on one bank or on the other there is this natural barrier as far upstream as the City of London, where the river flows between the gravel terrace on the north and other gravels and brick-earth on the south; even here there is a narrow flood-plain on the southern side, as is suggested by the name "Newington Causeway," still given to part of the road which transverses it from south to

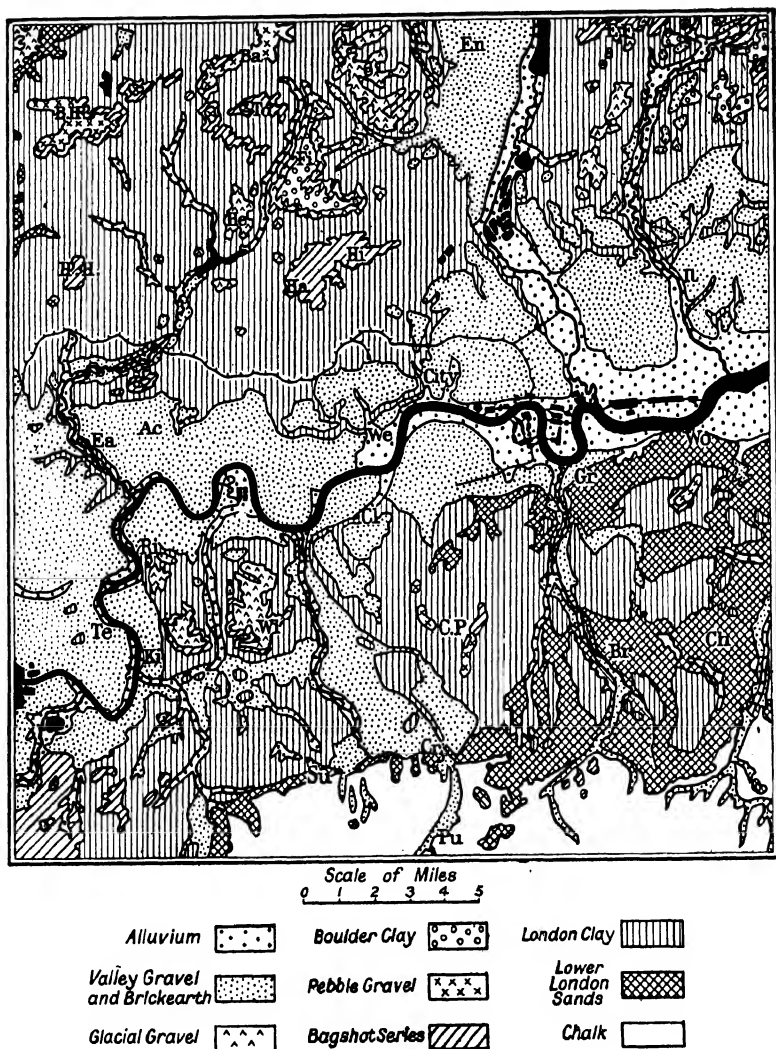


FIG. 17.—GEOLOGY OF THE LONDON DISTRICT.

The black areas in the flood-plain of the Thames below London Bridge are the docks; those in the Thames valley above Teddington and in the Lea valley are water reservoirs.

north. (Compare Figs. 17 and 18.) Yet here was a possible crossing-place of the Thames, and here London Bridge was built.

The chief factor in the position of London, therefore, was that it was the lowest bridge-place of the Thames, and consequently

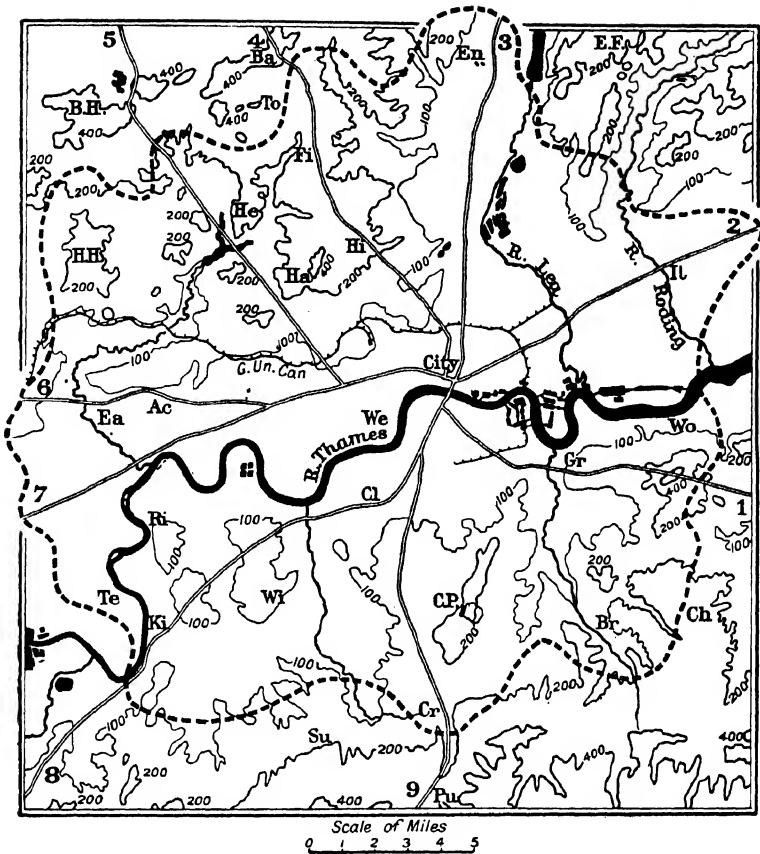


FIG. 18.—RELIEF AND TRUNK ROADS OF THE LONDON DISTRICT.

The broken line shows the approximate boundary of the completely built-over area.

- Roads: 1 = Watling Street and Dover Road.
 2 = East Anglia Road.
 3 = Ermine Street and Cambridge Road.
 4 = Great North Road.
 5 = Watling Street and St. Albans Road.

- 6 = Oxford Road.
 7 = Bath Road.
 8 = Portsmouth Road.
 9 = Brighton Road.

the point at which a land-route could cross from the Continent to the main body of Britain. At the same time, the bridge checked water transport, and hence at this point took place interchange between land and water traffic. London Bridge formed the nucleus and focus of the trade of London.

On the north side of the bridge, roads for continental traffic were able to radiate to all parts of the country, eastward, north-

ward and westward ; they led from London even south-westward, for the Wealden marshes and forests were a barrier against a direct coastal route between the narrow sea crossing and the south-west of England.

Moreover, Southern England was the most productive and the most densely populated part of Britain until the use of coal and iron in the north enabled mining and industrial development to balance the agriculture of the south. London was therefore not only the great port but also the most convenient centre of government for the country. Not the City of London, however, but Westminster was early selected as a royal residence and became the seat of the government. The site of Westminster was "Thorney Island," a patch of gravel rising out of the marshes of Thames-side about a mile above the City. At first a separate settlement, it was gradually joined to London by the outward spread of the metropolis. Indeed, the development of London, both in its extent and in its activities, makes it necessary to distinguish between its original site and position and those which it occupies at the present time.

It is easy to realize that with the increase of its population a town must extend over a greater area of which the original *site* may be but a small portion, and it is equally true that the significance of the geographical *position* may change, perhaps even to a greater extent. A situation on a shallow stream may suffice for a trading centre while communications are still mainly by road or river, but when ocean transport develops and trade with far-distant lands becomes important, a situation on a waterway which is navigable by great sea-going vessels is indispensable if the importance of the centre is to be maintained. London has been fortunate in having such a position : the river could be relatively easily dredged and docks provided to accommodate even the great ocean liners, enabling them to come far into the heart of the land, over 50 miles from the Nore Lightship off Sheerness.

International commerce became a matter of the greatest importance after the period of the Great Discoveries, when distant lands had been brought into close relationship with the Old World. Previously, Britain had been on the outskirts of the populous lands : it was almost like an outpost of civilization ; now, it may be regarded as situated in the centre of the land hemisphere and at the meeting-place of the great trade-routes.

Consequently, the position of London, as of the other ports of Britain, must be estimated from this point of view, and it is scarcely too much to say that while in its early history the most significant fact was that London was the focus of radiating land routes, now the emphasis has been largely transferred to the sea routes which lead from it not only to the adjoining continent but to all parts of the world.

In the course of centuries another change has occurred in this matter of geographical position. In early days it would be the natural conditions of a settlement which determined its accessibility and its importance as a nodal point, but when once its trade has become established, artificial routes are made and gradually assume greater importance as compared with natural ones. To facilitate communications first roads and then railways have been constructed and, once made, their very existence tends to increase the importance of the centre they serve. Similarly, the facilities provided for docking ships and for exchanging cargoes are a great factor in determining the destination of sea traffic. Further, natural hindrances to movement both by land and water have been removed by draining and dredging, by bridging and embanking. In many ways the human element counts for more and more ; nature makes possible man's activities in particular ways at particular places, and if he takes advantage of the possibilities thus offered, his works may in course of time transform some of the natural conditions and supersede others.

The Commerce of London.—Because of its long history and its magnitude, London gives marked illustrations of this interaction between man and his environment. As a port, it first utilized for the harbourage of vessels the mouths of the small creeks at the side of the Thames by London Bridge, but with the increasing size of ships, the great tidal rise and fall in the river, here amounting to over 20 feet at spring tides and 13 feet at neap tides, necessitated the provision of docks. These were constructed in the marshes below London Bridge, and behind the dock gates the water is held impounded during low tide, and the ships can lie in safety and their cargoes can be transferred without interruption. By the dock sides, wharves, warehouses, roads and railways have been built, and the face of the land has been changed beyond recognition. With the growth of trade and the increasing size of the shipping more and larger docks

ward and westward ; they led from London even south-westward, for the Wealden marshes and forests were a barrier against a direct coastal route between the narrow sea crossing and the south-west of England.

Moreover, Southern England was the most productive and the most densely populated part of Britain until the use of coal and iron in the north enabled mining and industrial development to balance the agriculture of the south. London was therefore not only the great port but also the most convenient centre of government for the country. Not the City of London, however, but Westminster was early selected as a royal residence and became the seat of the government. The site of Westminster was "Thorney Island," a patch of gravel rising out of the marshes of Thames-side about a mile above the City. At first a separate settlement, it was gradually joined to London by the outward spread of the metropolis. Indeed, the development of London, both in its extent and in its activities, makes it necessary to distinguish between its original site and position and those which it occupies at the present time.

It is easy to realize that with the increase of its population a town must extend over a greater area of which the original *site* may be but a small portion, and it is equally true that the significance of the geographical *position* may change, perhaps even to a greater extent. A situation on a shallow stream may suffice for a trading centre while communications are still mainly by road or river, but when ocean transport develops and trade with far-distant lands becomes important, a situation on a waterway which is navigable by great sea-going vessels is indispensable if the importance of the centre is to be maintained. London has been fortunate in having such a position : the river could be relatively easily dredged and docks provided to accommodate even the great ocean liners, enabling them to come far into the heart of the land, over 50 miles from the Nore Lightship off Sheerness.

International commerce became a matter of the greatest importance after the period of the Great Discoveries, when distant lands had been brought into close relationship with the Old World. Previously, Britain had been on the outskirts of the populous lands : it was almost like an outpost of civilization ; now, it may be regarded as situated in the centre of the land hemisphere and at the meeting-place of the great trade-routes.

Consequently, the position of London, as of the other ports of Britain, must be estimated from this point of view, and it is scarcely too much to say that while in its early history the most significant fact was that London was the focus of radiating land routes, now the emphasis has been largely transferred to the sea routes which lead from it not only to the adjoining continent but to all parts of the world.

In the course of centuries another change has occurred in this matter of geographical position. In early days it would be the natural conditions of a settlement which determined its accessibility and its importance as a nodal point, but when once its trade has become established, artificial routes are made and gradually assume greater importance as compared with natural ones. To facilitate communications first roads and then railways have been constructed and, once made, their very existence tends to increase the importance of the centre they serve. Similarly, the facilities provided for docking ships and for exchanging cargoes are a great factor in determining the destination of sea traffic. Further, natural hindrances to movement both by land and water have been removed by draining and dredging, by bridging and embanking. In many ways the human element counts for more and more ; nature makes possible man's activities in particular ways at particular places, and if he takes advantage of the possibilities thus offered, his works may in course of time transform some of the natural conditions and supersede others.

The Commerce of London.—Because of its long history and its magnitude, London gives marked illustrations of this interaction between man and his environment. As a port, it first utilized for the harbourage of vessels the mouths of the small creeks at the side of the Thames by London Bridge, but with the increasing size of ships, the great tidal rise and fall in the river, here amounting to over 20 feet at spring tides and 13 feet at neap tides, necessitated the provision of docks. These were constructed in the marshes below London Bridge, and behind the dock gates the water is held impounded during low tide, and the ships can lie in safety and their cargoes can be transferred without interruption. By the dock sides, wharves, warehouses, roads and railways have been built, and the face of the land has been changed beyond recognition. With the growth of trade and the increasing size of the shipping more and larger docks

were built farther down-stream, and now they have been formed in the marshes by Tilbury opposite Gravesend. Dredging, too, has deepened the channels, though the vessels have, of course, still to wait for the tide in order to leave the docks. Upstream, also, the river navigation has been controlled, and hundreds of barges daily take goods to the wharves above London Bridge.

The river is tidal to Teddington, and above that point there are locks, but there is relatively little traffic in this part of the river ; there is relatively little traffic also on the Grand Union Canal which connects the Thames with the waterways of the Midlands, utilizing the Colne valley and one of the wind-gaps of the Chilterns. The London end of this canal is shown in Fig. 18.

The great bulk of the inland traffic from the Port of London goes by railway or road. The terminal stations of the main railways are chiefly on the north side of the Thames, where they lie near the northern margin of the gravel terrace over which London had extended when they were built, but goods traffic goes to the docks and wharves by many branch lines. The river is crossed by about a score of railway and road bridges ; below London Bridge there is now the Tower Bridge, which opens up to allow shipping to pass ; there are also below London Bridge both tunnels and ferries, while central London has a network of underground railways linking north with south and reaching far out into suburban areas.

The facilities for communication have led many steamship lines to use the London Docks ; consequently the trade of the Port of London is of a very varied character, and has its origin or destination not only in " Metropolitan England " but also in the distant parts of the country. Thus commodities are imported not only for use in and near London but also for distribution throughout Britain. There is, moreover, the transshipment of goods to vessels going to other ports ; this latter activity represents the " *entrepôt* " trade which is a considerable fraction of the whole.

The largest group of *imports* into London consists of food-stuffs, and while other British ports share in the trade in such commodities as wheat, meat, dairy produce, sugar and fruit, which are brought by many shipping lines from various parts of the world, other commodities are almost a monopoly of the London trade ; tea is an outstanding example, for the shipping lines which serve China and India have their docking arrangements



[Aerofilms, Ltd.]

FIG. 19.—THE THAMES AT LONDON BRIDGE.

The view is taken looking down-stream over Southwark Bridge, Cannon Street railway bridge and London Bridge. The Custom House is on the north bank half-way between London Bridge and the Tower of London.

and warehouses largely in London, and the tea imported here is afterwards distributed to all parts. The second largest group of imports is composed of raw materials for manufacture, and of these wool is the most important, for about half the wool which comes to Britain enters the London Docks ; rubber is another great import and, like tea, is an example of a commodity coming mainly from an area served by lines with headquarters at London. A number of commodities containing oils and fats, such as various seeds and nuts, as well as crude oils for subsequent refining, form an important group in the raw materials imported into London. The smallest class of imports is that of manufactured goods ; these are of most miscellaneous character, headed by a group of worked-up fats, such as soap.

The *exports* are much less, both in value and in bulk, than the imports ; consequently many vessels go out in ballast. The relatively small classes of exported food-stuffs and raw materials are composed mainly of articles of foreign origin re-exported in the entrepôt trade. More important are the exports of manufactured goods ; these are largely of British origin and consist of woollen and cotton goods ; apparel of various kinds ; metals and machinery ; chemicals, dyes and drugs. In none of these cases, however, has London, as compared with other ports, a predominating share in the export trade, though it is clear that it draws much trade from the manufacturing areas which are sometimes regarded as the " hinterlands " of Liverpool, Manchester and Hull. The above facts suggest that it would be impossible to limit on a map the " hinterland " of the Port of London.

Associated with the actual transfer and transport of the goods entering and leaving London in all directions is a great amount of organization and clerical work ; this is carried on in offices which are naturally situated near the docks and wharves and in the City of London. There is also a great deal of work connected with the financing of these and other business dealings, and many banks have both head and branch offices in the City. The Bank of England, facing the Royal Exchange and the Mansion House, is the focus of this branch of London's activities. Indeed, St. Paul's Cathedral is hemmed in by narrow streets crowded with traffic and lined with shops and warehouses. The business of London is now so multifarious and so vast that the offices have been forced to spread westward far beyond the City,

and recently even in Westminster a large business quarter has developed, utilizing what were previously large houses of well-to-do residents as well as great modern office buildings.

Manufactures.—The primary reason, and resource, for the great urban population was trade and commerce, but a secondary reason, and resource, lies in manufacturing of many kinds. The needs of such a population in the way of houses, furniture, clothing and food, provide an enormous home market, while the facilities for transport allow distant markets to be easily reached ; moreover, raw materials can be easily brought in and the existence of the great population offers a practically inexhaustible labour supply. Consequently from early times industries arose, though after the Industrial Revolution these were over-shadowed by the rise of the great iron and steel and textile manufactures of the north and Midlands. Yet although the work in London was on a relatively small scale so far as each industry was concerned, it continued in innumerable forms, and London has remained the greatest manufacturing centre of the British Isles. The works were generally situated where transport was easy and land was cheap, i.e. in the flood-plain by the river-side, surrounded by the small crowded houses of the workers.

A group of industries closely connected with the facilities for importing raw materials, is located both by the docks and above London Bridge ; it includes sugar refineries and flour mills, while at numerous points along the river and the waterways connected with it are gas-works and generating stations for electricity.

There is now a strong tendency to decentralization, where this is possible, and manufacturing centres as well as residential districts are growing up farther afield, particularly in the northern and western sections of "Greater London." In these marginal districts there has been a great development during recent years, particularly of small factories making relatively small articles, e.g. food-stuffs, medicines, chemicals, clothing, electrical equipment, musical instruments, etc., for the requirements of the London region and for export. These works need relatively small amounts of raw material or small parts of metal work or wires, which can be brought by road or rail either from the London Docks or from the "heavy industry" centres of the Midlands and the north of England ; hence these new manufacturing districts are conveniently situated on the railways

and the new arterial motor roads leading northward, north-westward and westward from London.

Thus many such works have spread northward along the west side of the Lea valley, along the belt of river gravel and brick-earth. Factories have also extended in a north-westerly direction towards Watford. A third area of manufacturing activity has developed westward as far as the Colne valley, along the course of the Grand Union Canal. It utilizes this means of transport, however, less than the railway which runs close to it, and the modern roads constructed for motor traffic ; this latter form of transportation is very suitable for the small-scale production and scattered distribution characteristic of the new industries.

Factories in these outlying districts can obtain land more cheaply than in the congested areas, and are more healthily situated than most of those which were built at or soon after the time of the Industrial Revolution ; in some cases their products can be made better in the cleaner air. Moreover, the new workers' districts which have grown around them are better planned and afford opportunities for healthier and happier lives than the crowded areas of the ports and coalfields on which the older industries were based.

Government, Arts and Science.—While the City may be regarded as the centre of the commercial life of London, around Westminster are grouped institutions connected with the government of the country. Adjoining the Houses of Parliament, which are situated on the "Embankment" just above Westminster Bridge, is Westminster Abbey, and leading northward is Whitehall, flanked by the buildings of the various government departments. Buckingham Palace, the royal residence, is close by, on the farther side of St. James's Park.

In addition to the work connected with the government of Great Britain as a whole, there is the administration of the County of London carried on by its County Council and centred at County Hall on the south side of the Thames almost opposite the Houses of Parliament. Here matters which concern the whole of London are dealt with, but others of more local interest are the business of the numerous boroughs of which the County of London is composed. There are other boroughs of the conurbation outside this county, but these boroughs have their own councils and their own administrative buildings

within their respective boundaries. Finally, the "British Commonwealth beyond the Seas" is represented by Commissioners and Agents in London whose offices are in the neighbourhood of Westminster or between it and the City.

It may easily be imagined that in connexion with this complex work of administration, many people either live in London or visit it. Moreover, this centralization of government in the metropolis is a factor in bringing about the great amount of printing and publishing of newspapers, journals and books of all kinds; much of this work is localized in or near Fleet Street.

The existence of the large population in London itself, and the means of communication which lead to it from the other populous places, make it a very important intellectual centre. The National Gallery is not far from Westminster, and nearer the City is the British Museum, while another group of museums is situated farther west near Hyde Park. Several concert halls and "Broadcasting House" give such opportunities for hearing music as are afforded in no other city in this country; in the central district are many theatres.

Science, too, has its representation in the museums and in the meeting-places of most of the learned societies of Britain. Adjoining the British Museum are the central buildings of the University of London, though others are widely scattered, some being miles away in outlying suburbs.

The law has its quarter around the Royal Courts of Justice between the City and Westminster, while the medical profession is centred in Harley Street and adjoining streets near Regent's Park.

The cause of the *localization* of the solicitors and barristers near the Law Courts is obvious; but there appears little reason for the congregation of the physicians and surgeons in their district. There is a common tendency for a particular activity to be grouped in a small area, and this is often useful as, for example, in the close proximity of physicians, surgeons, dentists and radiologists who frequently are associated in their actual work. But there is sometimes little geographical necessity for the grouping being situated in its particular locality; in some cases the reason lies in the past when that position was of real advantage, and the present distribution is simply a case of "geographical inertia." Sometimes the reason is the tendency

of people to follow successful individuals, whose success may have been due to their own qualities rather than to their geographical situation ; it is often true that, provided the position is not a positive handicap, psychological factors may be more important than precise situation in determining geographical localization.

Urban Expansion.—For the workers in all the businesses, industries and professions which have developed in London, homes have had to be provided, and long ago the terraces and patches of gravel which were first settled proved inadequate. The London clay had the disadvantages of being liable to flood after heavy rains, and of supplying drinking water mainly from surface streams uncertain in volume and liable to pollution, but when engineering provided both drainage and a good water supply brought from a distance in pipes, London rapidly spread over the clay areas.

The present water supply is to some extent obtained from deep artesian wells which penetrate the clay to the porous chalk below ; these utilize water which has sunk into the chalk outcrops of the North Downs and the Chiltern Hills and has percolated through the porous sheet beneath the London Basin. The demands have been so great that this source has proved insufficient, and borings in the North Downs and Chiltern Hills show that the water-table has been lowered considerably by the amounts drawn off in recent years. The greater part of London's water supply is now taken from the Thames above London ; it is filtered and stored in the huge lake-like reservoirs situated near the river in its course between Staines and Teddington. The River Lea is also utilized, and the reservoirs spread almost across its valley at two places.

Houses have been built even on the low flood-plain of the Thames, in parts below high-water level. Quite recently streets near the river have been flooded and people drowned in basements. This occurred when the Thames rose above the embankments, the waters from upstream, swollen by heavy rains, being met by a spring tide exceptionally high because of a north-east wind driving the water up the river from the North Sea. Housing conditions have been very bad in these low-lying parts, but now they are being improved, and modern means of communication enable people to live farther from the centre of London.

A few generations ago, people who could afford the time and the money to live outside London itself formed residential suburbs on the patches of sands and gravels which stand above the London clay and were previously the sites of small villages. Hampstead, with its Heath, and Highgate are situated on Bagshot Beds north-west of the older settlements, and from their heights of over 400 feet, on a clear day one can see London stretching southward for miles. Still farther to the north-west, and later occupied, are Finchley and Hendon on the boulder clay and sands. To the west of these places, Harrow-on-the-Hill, with its well-known public school, is built on Bagshot Beds. Due west of London, such settlements as Acton and Ealing grew up on the river terrace gravels and brick-earth. South of the Thames similar developments occurred, as for example, where Clapham offered a site on terrace gravels adjoining the flood-plain of the river, Wimbledon spread from one of the patches of glacial gravel, and Bromley arose on the lower London sands. The Crystal Palace was placed on a patch of sands lying above the London clay, and it overlooks London on the south as Hampstead does on the north. River-side settlements, too, were invaded by the Londoners, e.g. Richmond, Kingston and Woolwich; at Greenwich, on a gravel-capped hill overlooking the Thames, stands the Royal Observatory from which longitude is measured and at which astronomers determine "Greenwich time." Eastwards of London there were settlements of less extent, for on the north side of the Thames the wide, marshy valley of the Lea offered a barrier to communications; moreover, as in most towns where the westerly winds prevail, people prefer to live on the windward side, less exposed to polluted air and smoke.

These more or less isolated settlements, however, did not suffice for the growing population of London, and the intervening districts of less desirable clay or alluvium were gradually occupied, till now practically all the area shown on the map as the London stow is built over, with the exception of parks and commons. Some of these are the "royal parks," once the private property of the Crown and therefore not available for building. It is noteworthy, too, that a number of areas of little agricultural value, e.g. the patches of glacial gravel in the neighbourhood of Richmond and Wimbledon, have remained unbuilt upon. For whatever reason the open spaces were left,

they are now of great value, for they ameliorate the conditions of the millions of people who live in this great sea of buildings, shut off from open country and often from clear skies.

Beyond the almost or quite built-over area of London there extend the strips of ribbon-development along the routes of the roads and railways, and the more distant "exclaves" of metropolitan settlement.

As the means of communication have improved, and particularly with the coming of the motor-car, many people have migrated from the centre to the outskirts of London or beyond it. The City is now almost uninhabited at night except for caretakers, and in many of the central parts residential areas have become business premises or dwellings for poorer people who cannot afford the cost of daily travelling.

The Features of London.—The London stow comprises areas of differing character which may be regarded as its "features"; they vary according to the economic activities and the related social position of their occupants, and the differences shown by their human geography have been in part determined by their physical conditions. To draw definite lines between these features is not always possible, but it is instructive to note their general characteristics, and they may be grouped in some such way as follows: (1) the flood-plains of the Thames and the lower Lea, with docks and wharves, warehouses, factories and workers' dwellings; (2) the dry gravel ledge north of the Thames comprising the City and Central London, the business and central trading areas; (3) an area in West London largely on gravel or (in Westminster) on reclaimed alluvium, comprising the administrative and well-to-do residential and shopping districts. These three areas form the core of the conurbation, and beyond them lie: (4) a wide encircling belt, on clay, brick-earth and valley gravel, of "working-class" and "lower middle-class" districts, with the houses crowded together and the main roads serving as local shopping centres; (5) gravel-topped hilly areas on the margins, with many large houses less closely packed and with more spacious gardens; (6) radiating stretches, also marginal, along the main roads and railways, with the newer small industries and associated residential and trading settlements. Lastly (7) there are parks, open spaces and commons scattered throughout the stow.

Population.—According to the census returns of 1931,

"Greater London," occupying an area of about 700 square miles, then had a population of over 8 million persons. This number represented more than one-sixth of the total population of 45 millions in all Great Britain, and it is to be observed that while this total showed a growth of a little under 5 per cent. in the preceding ten years, the metropolitan area showed an increase of nearly 10 per cent.¹

It is clear that with its constant and irregular growth, no hard-and-fast line can be drawn to mark the limit of the London conurbation, but as in the case of other areas, it has its own characteristics and life which mark it off from other regions and distinguish it as a geographical entity.

¹ A direct comparison with the whole of the British Isles is not possible, as no census was taken in Ireland in 1921.

CHAPTER V

WESSEX

THE term "Wessex" has no precise geographical significance but is conveniently used for the area lying between the London Basin and South-eastern England on the east and the Severn estuary and the uplands of Somerset and Devon on the west. The name is adopted from the Saxon Kingdom to which this area broadly corresponded, but parts of several markedly different geographical regions are included. It may be asked why such a varied area is treated in one chapter of this book; the answer is that the regions can here be easily compared and contrasted with each other, since they form a compact area and one easily surveyed upon a map; moreover, when the main characteristics of these regions are realized their study can be pursued in the wider areas of the Midlands and Eastern England.

From henceforth the geography cannot be examined in the same detail as hitherto; individual stows cannot (except occasionally) even be referred to, and tracts are the smallest regions that can be separately considered; it must therefore constantly be borne in mind that the tracts are in reality by no means uniform but comprised of stows of varying character.

The eastern half of this Wessex area is formed of chalk tracts of the same type as the North and South Downs, together with the included tract of the Hampshire Basin which is of the same type as the London Basin.

The chalk country of Wessex includes the broad mass of the Central Downs (comprising the Hampshire Downs and the adjoining Salisbury Plain in Wiltshire), the Western Downs south-west of the city of Salisbury and mainly in the county of Dorset, with the smaller Purbeck Downs branching eastward from the Western Downs near Dorchester. The northern limit of the Central Downs is set partly by the projecting tip of the London Basin and, back to back with this, by the Vale of Pewsey, which penetrates the chalk mass from the west near the town of Devizes. Thus there is an almost complete break between the Central Downs and the corresponding chalk

country lying farther north ; this latter includes a well-marked tract which extends from north of Devizes eastward past Marlborough as far as the valley of the Thames above Reading. This country clearly forms a unit area ; it is partly in Wiltshire and partly in Berkshire, and it will here be called the White Horse Hills tract, as in several places the turf on the slopes has been cut away to expose the chalk in the form of a horse ; the best-known white horse is on the northern part of the escarpment east of Swindon, overlooking a belt of lowland to which it gives the name of the Vale of White Horse (a part of the Oxford Clay Vale).

The White Horse Hills end eastward at the Goring Gap, i.e. the valley cut by the Thames through the chalk belt in its course above Reading ; east of the Goring gap the chalk country forms a different tract, the Chiltern Hills, which although outside Wessex will, for the sake of convenience, be dealt with in this section.

The Chiltern Hills.—In many ways the chalk tract of the Chilterns resembles that of the North Downs. There is an escarpment, here facing the north-west, which varies in height from about 600 to about 800 feet, and bears woods of beech and lower and less continuous growths of yew and juniper, while above are stretches of open downs.

The dip slope is largely covered with clay with flint, and in the east with more fertile loam ; this plateau area bears extensive areas of pasture and arable land, and great beech woods, charming in the fresh greens of spring and glorious in the golden browns of autumn. Dry valleys furrow the dip slope at relatively high levels, and the more deeply cut valleys have flowing waters and serve as routes along which are strung settlements of varying size ; proximity to the London Basin has affected development of these settlements very considerably, as it has affected those of the North Downs.

On the other hand, there are differences between the two tracts. While in the case of North Downs there are consequent rivers which have maintained their channels through the chalk plateau, in the case of the Chiltern Hills there are no such rivers cutting through the escarpment ; this is because the subsequent streams which have worn away the clay vale in front of the Chiltern escarpment have diverted most of the drainage from this lowland area south-westward by the Thame to the Thames,

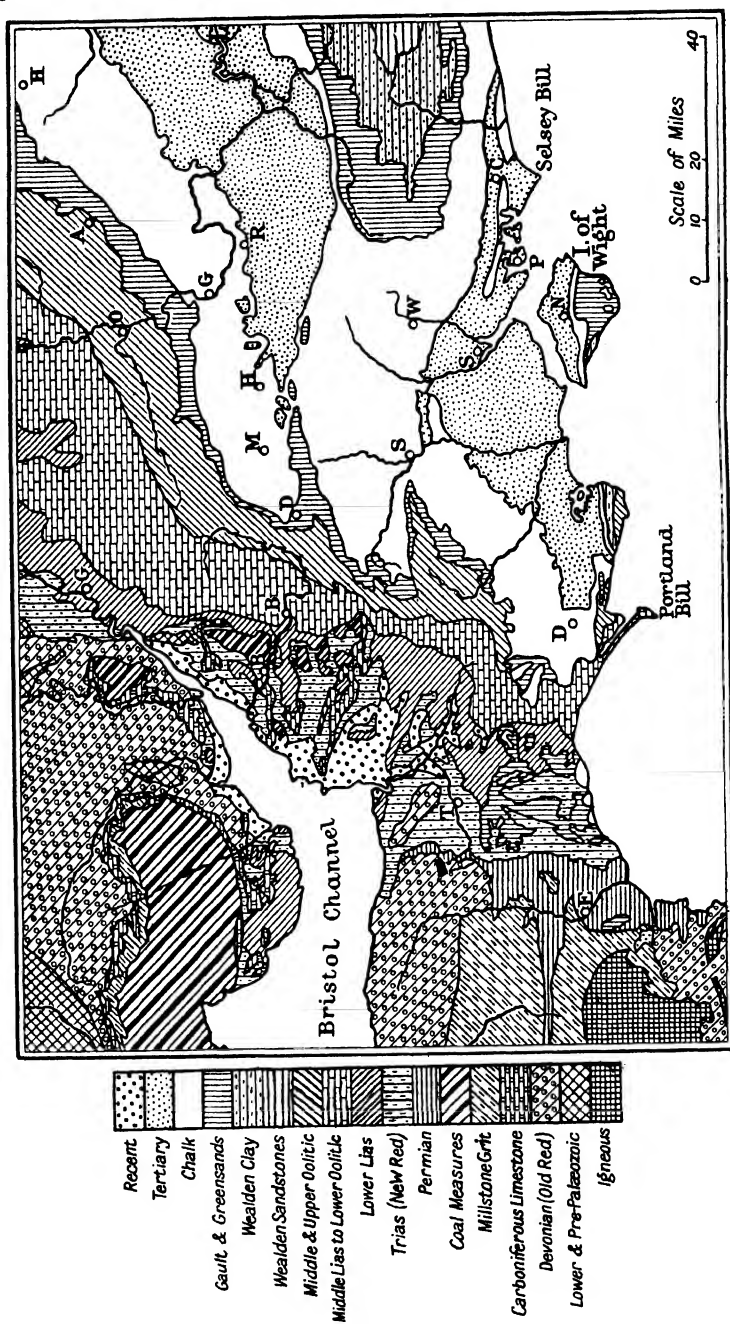


Fig. 20.—GEOLOGY OF THE WESSEX AREA.

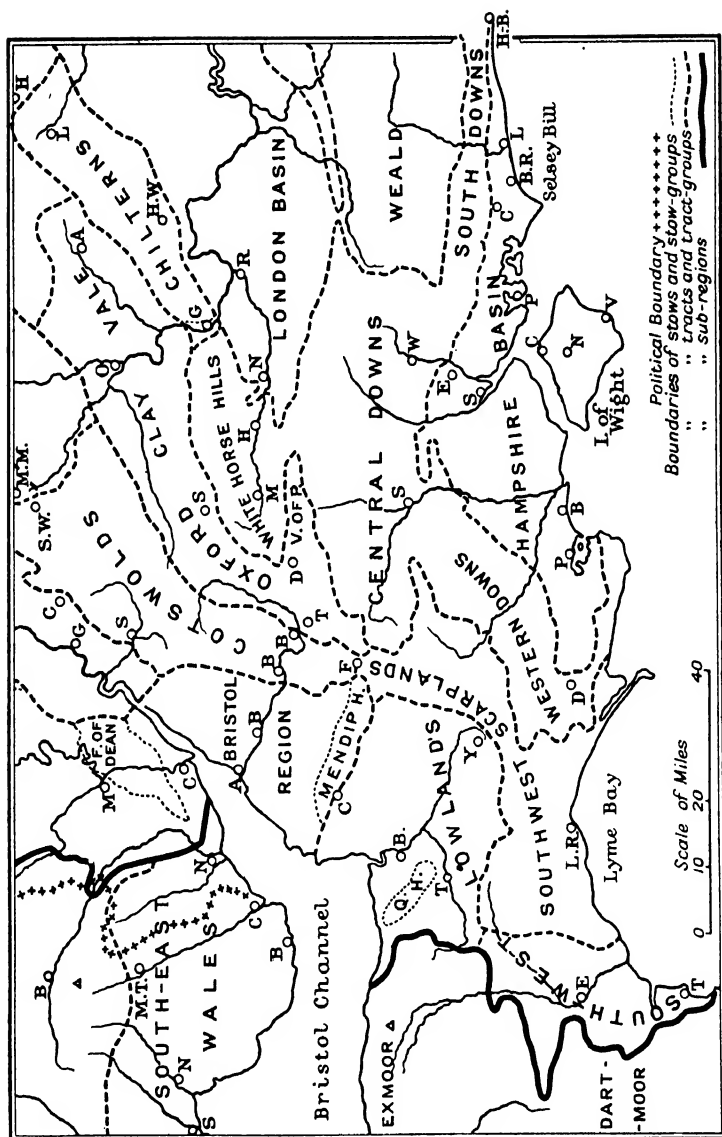


FIG. 21.—REGIONS OF THE WESEX AREA.

Note. By tract- (or stow-) group is meant a region composed of two or more closely related tracts (or stows) which adjoin and have very similar characteristics. E.g., all the chalk tracts shown in this map form one tract-group; while the region is too diverse to be regarded as a single tract, it cannot be considered as a distinct sub-region, because in certain respects it is akin to the other tracts of the English Lowland.

while the rest flows north-eastward to the Ouse. At an earlier stage of the evolution of the surface, the plateau of the Chilterns extended far beyond its present limit to the north-west and relatively large consequent streams flowed down the dip slope and cut wide valleys, but with the development of the lowland area of the Oxford region and the wearing back of the Chiltern escarpment, the upper waters were captured by the subsequent Thame and Ouse, and the consequent valleys were left with wind-gaps overlooking the plain. The larger of these valleys, however, were cut sufficiently deeply for their middle or lower courses to reach the water-table in the chalk, and therefore water is found in these parts of the larger valleys. Although the streams are relatively small they are of great value, being used not only for drinking water for man and beast, but also for irrigating "water-meadows" from which are obtained much rich grass and hay and, in some areas, water-cress.

Another characteristic of the Chiltern tract is that it forms a barrier between the metropolitan region and the industrial areas of the Midlands and the north; hence traffic between these regions goes either through the valleys at each end, i.e. through the gaps adjoining the towns of Reading and Hitchin respectively, or through the more deeply cut of the wind-gaps. In consequence, roads and railways follow several of the Chiltern valleys, and in them towns of some importance have grown up. Thus there is High Wycombe, near the London end of the westernmost of these Chiltern roads, at which a considerable furniture industry has developed, originally utilizing the great beech woods of the neighbourhood but now importing most of its timber. Luton, near the head-waters of the Lea, has for long been known as a centre of straw-plaiting and of making straw hats. This is another example of local supplies having given a start to an industry, but a more important development at Luton is that of engineering and the making of motor-cars—a case in which cheap land and efficient means of transport between the sources of raw material and the markets enable new firms to compete with those situated in the older industrial districts upon or near the coal- and ironfields.

The north-eastern boundary of the Chilterns is taken to be the wide gap in the escarpment near which the town of Hitchin has grown up, and the valley which runs from this town to the Lea at Hertford. East of this valley, the chalk ridge is lower

and has been over-ridden by the ice ; the resultant characteristics therefore mark it out as being part of the East Anglian region.

On the west the Chiltern Hills are separated from the White Horse Hills by the Goring gap, a deeply cut valley about a mile wide, through which the Thames meanders.

The White Horse Hills.—If the Chiltern Hills have certain resemblances to the North Downs, the White Horse Hills are more like the South Downs, for they have relatively small areas where clay with flints covers the chalk and favours the growth of woods, but wide spaces of high, open downland. This is most marked in the west, where the country rises to nearly 1,000 feet.

The chalk escarpment describes a great curve facing westward north of Devizes, and turning so that it faces northward where it overlooks the Vale of White Horse. The chalk strata have a very gradual dip over much of the region and only near the Chilterns is there a marked dip slope. As a whole, the White Horse Hills tract does not show clear traces of the work of former rivers, as is the case in the Chiltern Hills.

Because of the almost horizontal arrangement of the strata and the absence of former streams, there is greater uniformity in the relief than in the case of the chalk plateaus already considered. Seldom are valleys cut deeply enough to reach the water-table, and consequently there are few constant streams and the country is relatively dry. Over wide areas sheep-farming is the main resource and, as in the case of the South Downs, it is associated with the growing of wheat and barley ; the absence of trees and even of fences on these uplands gives a feeling of great space and from the higher ridges one can scan wide horizons. The quietude and sense of remoteness is due also to the fact that the region lies apart from traffic-ways which connect the London Region and the other densely populated parts of England.

Only one route of importance crosses the area, that of the "Bath Road" from London, and this has had little influence on the development of the country through which it runs. Leaving Newbury, the route proceeds westward up the Kennet Valley past Hungerford and Marlborough, and then over open downland until it descends the western escarpment into the upper valley of the Bristol Avon. The Kennet-Avon canal

crosses the southern margin of the region from Hungerford into the Vale of Pewsey and so joins the Thames to the Avon, but this canal is now derelict.

One branch of the railway which connects London and Reading to the west of England follows the canal route along the southern margin into the Vale of Pewsey, while the other utilizes the Goring gap and the Vale of White Horse ; consequently there is no important railway route through the region. Hungerford and Marlborough lost a considerable part of their significance when the Bath Road was superseded by railways, but now that motor transport has become important they lie once more on a traffic route, thus affording a good example of how the value of geographical position may change. Marlborough gives also an illustration of a type of settlement common to the chalk country : it is a town consisting (till quite recently) only of one long, wide street enclosed in a narrow valley.

The Kennet valley is exceptional in the region in having a constant stream which has deposited alluvium and produced rich, irrigated water-meadows. In this valley, and where water is available on parts of the downs, there has been, of late years, an increase in the keeping of cattle, both for stock raising and for milk production, for with modern methods of transport even such remote districts as the White Horse Hills contribute to the needs of distant, densely populated areas.

On the south-eastern side of the region, the chalk dips gently beneath the clays and sands of the London Basin, but on the south-west it ends in a steep scarp overlooking the *Vale of Pewsey*. The structure of this vale gives an example of a denuded anticline, for here the strata have been bent into a marked, though narrow, upfold running in an east-west direction ; the chalk top of the upfold has been removed and the Upper Greensand lying beneath it has been exposed and worn away to form a valley differing in almost all respects from the chalk uplands. A fertile soil has encouraged market-gardening and the growth of fruit for Bath and Bristol, and the production of milk for the metropolis.

The Central Downs.—It may now be realized that the various chalk areas of Southern England are parts of one great sheet of chalk. This sheet has a westward-facing escarpment which extends from near the south coast in Dorset northward and eastward into East Anglia. From this escarpment the chalk

sheet dips on the whole eastward or south-eastward, and in parts, as in the London Basin and the Hampshire Basin, it has been bent down into synclines and covered by layers of clay and sands. In other parts it is raised into anticlines and worn away entirely, as in the Weald and the Vale of Pewsey. Thus it remains to form the surface only between these marked synclines and anticlines. Moreover, less marked upfolds and downfolds cause the sheet to be more or less elevated and its surface conditions to be thereby modified. In the case of the central Downs these bendings or warpings of the chalk may be traced as a guide to the main characters of the country.

In the area of the *Hampshire Downs*, the chalk is highest in the east and the north. On the eastern margin it is brought up by the Wealden anticline and overlooks the Gault-clay vale by a steep escarpment rising to over 800 feet. In the northern part the chalk is bent up steeply from below the lower Kennet valley and then dips on the whole southward, so that the plateau country becomes lower until, in the latitude of Winchester, an east-west warping causes a ridge of higher land through which the River Itchen has cut its valley ; in this gap the city of Winchester has grown up. South of the Winchester ridge the chalk again dips, and in a few miles disappears below the sands and clay of the Hampshire Basin. The higher valleys of the Hampshire Downs, except after much rain, are dry, but the more deeply cut have in them the constant waters of the Test, the Itchen and their tributaries.

Because of differences of altitude and the partial surface cover of clay with flints, there are variations in the soil conditions and the vegetation, but taken as a whole this tract may be compared in its appearance and utilization with the South Downs. While wheat and barley are grown as rotation crops, most of the land is under grasses or root-crops, and upon this land sheep are folded. The region is crossed by a number of routes leading from north and east to Southampton Water, and several of these converge on Winchester, a city of relatively greater importance in the past when it was at a nodal point in the non-forested, and therefore more utilized, parts of Southern England.

Salisbury Plain.—This area is sometimes referred to as the Wiltshire Downs, though the county of Wiltshire is by no means conterminous with this chalk country. It forms a counterpart to the Hampshire Downs, for it is highest in the

west and the north whence the chalk sheet dips towards the Hampshire Basin, and it is brought up again by an east-west ridge in the latitude of Salisbury. Here the Salisbury Avon has cut a gap similar to that at Winchester, and towards the Salisbury gap converge all the streams of this chalk plateau; Salisbury is therefore a city which, in its situation, history and development, may be compared with Winchester.

The Salisbury Plain region is a high, gently rolling plateau of open, treeless country and wide views. Traces of very early settlements in this region remain in Stonehenge (a circular group of huge megaliths a few miles north of Salisbury), in "Old Sarum" (the predecessor of "New Sarum," the modern Salisbury), in many so-called "British" camps and ancient trackways which connected them. The region now supports but a scanty population, and great stretches of poor and rough pasture are utilized as areas for military training and manœuvres.

The Western Downs.—These are more varied in character; in the north-east is the wooded Cranborne Chase while the western portion is more open. This most southerly part of the chalk sheet extends westward in a relatively narrow projection beyond Dorchester; here it is bounded by escarpments on the north, on the west and also on the south, where it practically reaches the English Channel in Lyme Bay. East of Dorchester the chalk is bent into a rather sharp syncline and covered with the clays and sands of the Frome river valley, the western tip of the Hampshire Basin. South of the Frome valley, the chalk sheet rises again in the narrow Purbeck Hills, a wind-swept ridge, bearing a short springy turf and a low growth of gorse and other bushes, which forms the northern rampart of the "Isle" of Purbeck.

At their eastern end these hills are cut short by a subsidence which has let the sea into the bay which may be called the Bournemouth Bay, but on the farther side of this inlet the chalk reappears in the Isle of Wight. A belt of high downland runs across the island from the "Needles," a group of broken chalk stacks, on the west, to Culver Cliff on the east. South of this belt the chalk sheet was bent up into a flat anticline of which the top has been worn away. Consequently, the layers beneath the chalk have been exposed, and south of the high chalk belt a large part of the Isle of Wight is lower land formed of Lower Greensand; but patches of the chalk have remained at the south

of the island where there is again high downland forming the chalk-capped promontory of St. Catherine's Point.

The Hampshire Basin.—As a result of these warpings of the earth's surface, the Hampshire Basin is almost triangular in form, completely bounded by chalk outcrops on the north-east and the north-west, and on the south by the belt of chalk broken by the subsidences which have allowed the sea to penetrate on either side of the Isle of Wight. This tract has been largely filled in with sands and clays somewhat similar to those of the London Basin, but the clay areas are less extensive, sands cover a large proportion of the region and there are wide stretches of gravel. The last formation tends to produce a rather barren type of country, with a poor vegetation covering of heath, which is exemplified in the New Forest situated between Southampton Water and the Solent. Large parts of the New Forest, however, are underlain by less permeable loamy soils, and even by wet clay; on the former there are woods of relatively recently planted pines, while on the latter are deciduous trees, largely oaks, of ancient growth. As a whole, the Hampshire Basin is not a fertile region, but it has become more productive with the growth of a market by the settlements of the coast and by Southampton Water. The demand for dairy produce has helped the keeping of cattle by the "water-meadows" of the rivers, and the better soils yield fruit and vegetables. The most marked development has been on the loamy belt which extends between the South Downs and the sea; the western part has been called "strawberry-land," while near Worthing are large market-gardens where tomatoes and other produce are grown under glass.

In this coastal belt east of Southampton Water, a minor upfold brings the chalk to the surface (see the geological map), and so adds to the variety of soils in the area. Behind Portsmouth, the chalk rises to a narrow ridge known as Portsdown—a small exclave of the South Downs.

Along the coast are a number of watering-places, including Bournemouth built among pinewoods on a low sandy plateau, and the small port of Poole by the broad and beautiful Poole Harbour, which is the "drowned" portion of the heath-land called "Egdon Heath" by Hardy in his Wessex novels; Bognor Regis, Littlehampton and Worthing, being nearer the metropolis, are much visited by Londoners. Inland, two settlements

whose names show their Roman origin, Dorchester and Chichester, are situated at the western and eastern margins of the Basin respectively; these are examples of settlements which grew where roads cross the borders of regions of differing type.

The largest towns, however, Portsmouth and Southampton, owe their development to their maritime connexions, and their position is associated with the subsidence which separated the Isle of Wight from the mainland and turned the lower valley of the Test and Itchen into the broad Southampton Water. Portsmouth is a naval station, and the settlement around it numbers over a quarter of a million inhabitants. As a port, Southampton has the advantages of a sheltered situation with a deep-water approach and "double-tides" which bring high-water four times daily and allow large vessels to reach the quays at almost any time. These advantages, added to the provision by the Southern Railway of efficient train services, accommodation for goods, and docks which can meet the needs of the largest ships, have induced many lines to use Southampton. Moreover, this port is nearer than the more easterly and northerly ports of the British Isles to all overseas commercial centres except those of Northern Europe and Northern America, and is therefore particularly well situated for rapid transit. Consequently, Southampton is the first ocean-passenger port of Britain and has a great traffic in such commodities as meat, fruit and vegetables; continental liners also call at Southampton and take British manufactured goods to transatlantic ports. The "hinterland" of Southampton is therefore very extensive and includes both the Midlands and the north of England, though its total trade is less than that of the Mersey and Humber ports adjacent to the great industrial areas. The conurbation which centres upon Southampton has a population of nearly 200,000 persons and is increasing considerably.

The Isle of Wight.—Reference to the geological map will show that while the southern part of the Isle of Wight is formed of chalk and of the sandy and clayey layers which lie beneath it and are akin to those of the Weald, the northern part is covered with the sands and clays of the Hampshire Basin. This northern portion is low, much of it is tree-covered, and the subsidence which has brought into existence the larger inlets of the mainland has drowned the valleys of the small rivers of the north of the island. Consequently the Isle of Wight is composed

of three main types of country, which have resemblances to different tracts of South England, viz. the Downs, the Weald and the Hampshire Basin.

On the other hand, the geological history of this part of the earth's crust has resulted in these three types of country being brought into close relationship to each other and also isolated from other areas. In the centre of the chalk ridge which traverses the island, a marked gap allows the waters of the southern portion of the area to reach the northern coast ; road and rail routes utilize the same gap, and as a consequence the administrative seat of the island, Newport, has grown up at this central point, and from it means of communication radiate to all parts. Moreover, if the interior of the Isle of Wight shows marked differences, the coast has this in common, that there are watering-places almost all around it. These include Cowes, a centre of yachting and yacht-building, in the north, and Ventnor in the south, a resort beloved of invalids who appreciate a place with a warm and sunny aspect to the sea and sheltered from north winds by the cliffs which rise behind it.

Considered as a unit of geographical study, the Isle of Wight therefore presents something of a problem. On the one hand, it is a small and compact area united in certain ways and very definitely isolated from other parts of England, but on the other hand it does not exhibit that unity of character which is found in the case of the other regions of the lowest order. Most geographers would probably find it convenient to treat it as a unit for study, and from that point of view it would be regarded as a stow, yet its features resemble those found elsewhere in different stows and, indeed, in different tracts. Consequently it may be well to term it a "composite" stow, in contradistinction to the "simple" stows hitherto encountered.

Such composite regions are not infrequent ; similar ones are met with where crustal movements have brought different structures into close proximity and perhaps cut them off from neighbouring regions, while another type of composite region is found in tropical latitudes where a mountain mass rises steeply to great altitudes and consequently has closely adjoining variations in its surface conditions, climate and vegetation.

The Cotswolds and the Adjoining Clay Vales.—The general nature of the country between the White Horse Hills and the Severn near Gloucester can be seen from the geological

section in Fig. 22. Beneath the chalk escarpment stretches a low area, which is drained by the upper courses of the Bristol Avon and the Thames; this valley is largely floored by clay known as "Oxford clay" because it underlies Oxford farther to the north-east, and it forms part of the *Oxford Clay Vale* tract. The plain is broken by low hills where thin layers of limestone occur among the clay, but most of it is a rather damp country where cattle rearing is the main resource, and in the small towns are "factories" producing cheese and condensed milk, and also bacon and sausages. At Trowbridge and Frome near the southern end of the Vale, there are the survivals of the "West of England" woollen industry, relatively more important two or three centuries ago.

Rising westward from beneath the Oxford clays are a series of rocks largely formed by limestones, which are distinguished by being composed of small, rounded grains and are therefore called "roe-stones" or "oolites." Being porous, they are more resistant to weathering and stream-action than the clays, and they therefore form a gently tilted plateau, with its steep scarp facing north-west and its dip slope descending to the south-east. This scarped ridge is the *Cotswolds* or *Cotteswolds*, and because the oolitic limestone rocks belong to the system known to geologists as the Jurassic system, the escarpment is sometimes called the Jurassic escarpment.¹ In the southern part of their extent the Cotswolds rise to a height of over 800 feet, and the plateau forms a region of rather bare-looking country, with few trees and generally large fields separated by low stone walls. The limestone is, of course, rather dry, but on it develops a reddish, loamy soil which recalls that of the chalk, and is well adapted to the growing of barley; wheat, oats and root crops are also obtained, and there are good grass pastures for sheep, but there are no longer the great flocks of long-woolled sheep which gave much of the raw material for the once-famous woollen industry.

The valleys which furrow the dip slope and have in them the head-streams of the Thames and the Bristol Avon are more wooded than the levels of the plateau, and so is the irregular scarp slope.

In the southern part of the Cotswolds the escarpment is cut into by two rivers. The Frome and its tributaries which meet

¹ The succession of geological formations is shown in the table in Appendix I.

near Stroud have reduced the plateau in this neighbourhood to a series of valleys and slopes of park-like country unlike most of the region. Here Stroud still makes "broad-cloths," and the rapid streams of the scarp once gave water-power for a number of weaving towns and villages. The water sinking through limestone dissolves some of it and becomes "hard," and is then unsuitable for the woollen industry, but there are beds of porous sandstone between the limestones, and these sandstones provide the water used for the manufacture.

At the southern end of the Cotswolds, the Bristol Avon cuts right through the plateau in a somewhat gorge-like valley. At its eastern end is situated Bradford-on-Avon, another of the old woollen industry centres; while at Bath near its western end hot springs gave rise to a health resort as far back as Roman

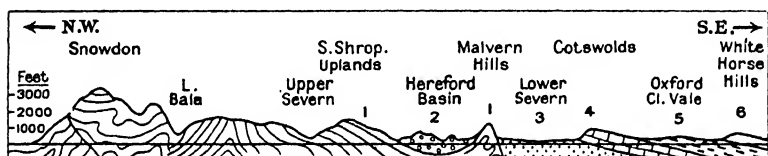


FIG. 22.—SECTION FROM NORTH WALES TO WESSEX.

1 = Lower and Pre-Palaeozoic Rocks. 2 = Old Red Sandstone. 3 = New Red and Lower Lias Sands and Clays. 4 = Jurassic (Middle Lias and Lower Oolitic) Limestone. 5 = Middle and Upper Oolitic and Gault Clays. 6 = Chalk.

times, and this city is to-day a large residential centre. In this neighbourhood limestone is quarried for the "Bath stone" much used for ornamental building purposes.

The escarpment of the Cotswolds overlooks the *Vale of Gloucester*, a lowland through which the Severn meanders. Near Gloucester the plain is largely formed of clays and marls, the "Lias" beds of the geologists, while close to the river is a belt of alluvium. This country is low, and some of it marshy and liable to flood; like the Oxford Clay Vale, it is much used for cattle-keeping and dairying.

This area of the Cotswolds and the plains on either side are parts of tracts which extend a considerable distance north-eastward into the Midlands of England and will be further considered in the next chapter.

It may be noted that the three regional belts between the chalk hills and the Severn, and the geological divisions adopted in the maps of this book, do not correspond with the belts and

divisions as shown on the ordinary small-scale geological maps. (1) The Oxford Clay Vale includes a narrow strip of the Lower Chalk, Greensands and Gault, and a wider band of the Oxford clays and other layers of the so-called "Upper and Middle Oolitic," in which there is much more clay than oolitic limestone and which have little resistance to erosion; (2) the Limestone Belt includes the Lower Oolites and also the Upper and Middle Lias with important beds of limestone and a resistant marlstone; (3) the Severn Lowland comprises the less resistant Lower Lias and, farther west, the marls, clays and sands of the Triassic system.

The following table brings out the difference between the regional and the usual geological groupings.

Regional Belts.	Geological Divisions.
The Clay Vale	Lower Chalk Greensands and Gault
	Upper and Middle Oolitic
The Limestone Plateau	Lower Oolitic
	Upper and Middle Lias
The Severn Plain	Lower Lias
	Trias (New Red)

The Bristol Region.—The area through which the Avon flows after leaving the Cotswolds is distinguished from the Vale of Gloucester by its structure and by its trading situation, and may be termed the Bristol Region. From the diagram in Fig. 23, it will be seen that here is a basin of rocks known to geologists as "carboniferous," and consisting of three groups: at the base a massive "carboniferous limestone" (which in England is generally not carboniferous in the sense of containing coal); above, a layer of

"millstone grit"; at the top, "coal-measures," consisting mainly of sandstones and shales among which are interbedded seams of coal.

It will also be observed that on the eastern side the basin of Carboniferous rocks is covered by the Lias rocks which contain beds of limestone forming the lower part of the Cotswold scarp. Below the Lias comes a layer of sandstones and marls known as "New Red," to distinguish them from the "Old Red" sandstones which were formed at a much earlier period of the earth's history and appear on the surface farther west in Britain. A considerable part of the surface of the Bristol region, especially to the south of the line of section, is formed of the New Red sands and marls.

The Bristol coalfield is not a large one; indeed, it is one of the

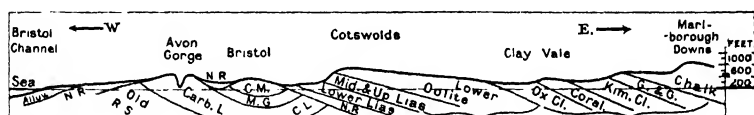


FIG. 23.—SECTION FROM THE BRISTOL CHANNEL TO MARLBOROUGH DOWNS.

Note that a belt of Corallian limestone, between the Oxford and Kimmeridge clays in the so-called Upper Oolitic strata, forms a low ridge in the Vale of the Upper Avon.

smallest of those of the British Isles, and the relatively few pits are east and south-east of Bristol.

The position of the region from the point of view of trade can be seen from an atlas. The Bristol Channel presents a natural entry for shipping, but above the mouth of the Avon the Severn is much encumbered with sand; consequently the Avon mouth provided a convenient harbourage with a river which was navigable to a "bridge-place," i.e. "Brigstow" or Bristol. Moreover, there was here an easy and short way, *via* the Bath Road, to London through what was once one of the most populated parts of Britain. Bristol early became a great port and a great city; and its importance increased after the foundation of British Colonies across the seas, whence came slaves, tobacco and sugar. Raw tobacco is now imported for manufacture, and sugar and cacao for the other staple manufacture of chocolate. Modern vessels cannot reach Bristol, and an outport has been constructed at Avonmouth where, besides tobacco and sugar,

much wheat and fruit, especially bananas, are landed. About half a million people live in Bristol and the surrounding region.

West and south-west of Bristol, the Carboniferous limestone rises to form the "Clifton Downs" through which the Avon has cut a remarkable gorge. Farther south the region is brought to an end by the greater limestone plateau of the *Mendip Hills* and the lower hills which continue their direction westward and even project into the Severn estuary. The Mendip upland is a "horst," i.e. an uplifted and fault-bounded block, composed of the hard Carboniferous limestone, almost flat-topped and rising steeply on all sides. The porous limestone bears little but grassland on the western and higher portion, where it reaches over 1,000 feet, but there is more cultivation and settlement on the lower, eastern part. From the limestone, zinc and lead ores were once mined, but this resource has now practically disappeared. Rain-water sinks into the rocks and along cracks, which it widens, by dissolving the limestone, into underground tunnels. In these the water collects as subterranean streams, which at parts of their course form grottoes and caverns. When the roof of such a tunnel is worn away by surface weathering and erosion a gorge results, and the most famous of such gorges in England is that at Cheddar, which winds up the steep western edge of the Mendips and has the entrances to some much-visited caves.

The Bristol region may be regarded as a composite tract, for while those areas formed by the New Red and Lower Lias strata are essentially continuations of the Lower Severn Plain, the continuity is broken by the small coalfields and the uplifted plateaus of Carboniferous limestone, which are closely related to South Wales in their structure.

The South-west Scarplands.—In the relatively narrow space between the Bristol Channel and the Mendip Hills on the north and Lyme Bay and the Western Downs on the south, several geological structures have been, as it were, thrust close together and two more composite tracts have been formed.

Immediately west of the chalk and north of Lyme Bay, the South-west Scarplands are composed of strata to which we have already referred, viz. Greensands, clay and limestones; the differences in the composition of the layers are accompanied by differences in the relief and in the appearance and utilization

of the land somewhat like those already described in connexion with the broader outcrops of the same series of rocks.

From beneath the chalk a narrow and broken strip of Greensand rises to a moderate elevation ; west of this, a wider belt of Oxford clay gives a lower stretch of country ; next, the Jurassic limestones form a relatively elevated belt, though they have a less marked scarp than in the Cotswolds. Finally, the western part of the South-western Scarplands is a plateau, known as the



[Judges' Ltd.]

FIG. 24.—THE CHEDDAR GORGE IN THE MENDIP HILLS.

Note the narrowness of the gorge, the massive structure of the tilted block of Carboniferous limestone and the scree formed of small weathered fragments.

Blackdown Hills where it overlooks the Vale of Taunton and reaches a height of nearly 1,000 feet. The higher levels of this plateau are formed of Upper Greensand, which here in the west of England is thicker and more resistant than in the east. The plateau has a southward tilt, and is furrowed by steep-sided valleys draining to the English Channel. The higher areas are infertile, open and mainly uncultivated, but the valleys, which have been cut through the sheet of Greensand to the New Red marls lying beneath it, have a fertile soil and productive fields and are well populated.

The South-west Lowlands.—West of the Mendip Hills and the South-west Scarplands is another composite tract, in general low-lying, to which the name South-west Lowlands may be applied. It consists of two portions, forming parts of the counties of Somerset and Devon respectively, separated from one another by a narrow, isthmus-like gap between the Blackdown Hills and the south-east corner of the Exmoor Upland.

The northern portion, the *Somerset Lowland*, has a nucleus in the great Plain of Somerset, much of it low and filled with alluvium brought down by the streams from the surrounding uplands. Of these rivers the largest is the Parret, which winds sluggishly through the naturally marshy region of Sedgemoor. This fen-like country, with its extensive peat bogs, has now been drained, and its flats support more dairy cattle than almost any other English area of the same size.

The only other district in England which has such a concentration of cattle is the somewhat similar Cheshire Plain, and the climate of the west of England is an important factor in both cases. The rainfall is heavier than in the east, and promotes an abundant growth of grass. Moreover, since the winters are warmer there is a shorter period in which growth is checked and the openness of the winter is a further advantage in permitting the pasturage of the cattle in the fields.

Although modern rapid transport allows milk to be carried very considerable distances, regions such as this, which are far from the great centres of population, tend to use much of the milk supply in the production of cheese and butter. Such products are made in large quantities at towns and villages situated on the higher margins of the lowlands, e.g. at Cheddar, at Yeovil on the Yeo tributary of the Parret, and at Taunton on the Tone tributary of the Parret; the last two towns are railway junctions of some importance. Bridgwater, at the head of the Parret estuary, is the small port for this region.

The south-western part of the Plain of Somerset is formed by the undulating Vale of Taunton, where the soil is formed from New Red marls and sands; it is a very fertile district, with great apple orchards from which cider is made.

Rising steeply from the west of the Plain of Somerset and north of the Vale of Taunton is the high mass of the *Quantock Hills*. In practically all respects this small region resembles the neighbouring uplands of Devon, from which it is separated

by a narrow valley ; consequently it may be considered as an exclave of the Devonian Upland region.

The portion of the South-west Lowlands which is situated in Devonshire may be called the *Exeter Lowland*, for that city lies in the centre. The greater part of the region is drained by the River Exe, and consists of a lowland floored by sands and marls, some being of New Red age, and some rather older and known as Permian. This is a fertile land, with orchards of apple and other fruit trees and rich pastures for cattle, though here raised for beef more than for dairy purposes. At the lowest bridge-place of the Exe stands the cathedral city of Exeter, where the river is crossed by the most important rail and road route to the South-western Peninsula of England ; moreover, as a relief map shows, the arrangement of the surrounding uplands allows roads from Exeter to penetrate between and around them to all parts of Devon, and hence it is a convenient administrative centre for that great county.

Along the south coast of these south-western tracts are a number of seaside resorts of which the largest is Torquay ; these have a double advantage from the point of view of the climate, in that they enjoy exceptionally mild winters and also a very high number of hours of sunshine, due in part to the relatively low rainfall resulting from their sheltered position in the lee of the high mass of Dartmoor.

This great upland, with Exmoor farther north, clearly marks the beginning of another and markedly different type of country, which has greater affinity with Wales and other regions of the west of the British Isles than with the regions hitherto considered. The Devonian Peninsula will therefore be treated in a later section of this book, and we now turn to the study of another area of the English Lowland.

CHAPTER VI

THE MIDLANDS

THE term "Midlands" is here used as a convenient geographical expression for the country between the White Horse Hills on the south and the Pennines on the north, the Welsh Upland on the west and the lowlands draining to the Wash on the east.

Although it is a large area, most of it may be regarded as a north-eastward extension of the three structural belts which in the last chapter were shown to occur between the White Horse Hills and the Severn below Gloucester, viz. the Oxford Clay Vale, the Cotswold Limestone Plateau and the Lower Severn Plain formed of clays and marls.

Oxford Clay Vale.—This region widens towards the east, between the chalk escarpment and the lowest part of the Cotswold dip slope, to the neighbourhood of the City of Oxford. Here the Cherwell, a tributary of the Thames flowing from the limestone belt on the north, meets the Thames, which changes from its eastward direction to flow southward through the Goring Gap. For centuries, Oxford has been famous as the quiet seat of a great University, but recently large motor manufacturing works have brought industrialization to its outskirts. Another industrial development has occurred in the south-western part of the Vale of Oxford at Swindon, where the railway from London which skirts the White Horse Hills has an important junction. As this place is centrally situated in the Great Western Railway system, it was selected as a convenient site for the Company's chief engineering, carriage building and repairing works.

Below Oxford, the Thames receives the waters of the Thame which drains the Vale of Aylesbury, overlooked by the Chiltern Hills and well known for its dairy farming. Aylesbury is the county town of Buckinghamshire, which, like the county of Oxford, stretches across the chalk plateau and the clay vale to the limestone belt. A few miles east of Aylesbury the water-parting between the Thames and the Great Ouse marks the end of this region, for the water-parting approximately corresponds

with the limit of glaciation, and the continuation of the Vale drained by the Great Ouse will be treated with Eastern England in the next chapter.

The Midland Limestone Belt.—This tract-group rises north-westward from the Vale of Oxford to an escarpment of greater height in the north part of the Cotswolds than in the south, for east of Cheltenham its highest parts reach an elevation of a little over 1,000 feet, and in this region it also attains a greater breadth. The dip slope of this Cotswold plateau is furrowed by broad and deep valleys in which the small headstreams of the Thames seem like “misfits,” and from this disparity it has been argued that the limestone plateau once extended farther north-westward and was cut by greater streams than those of the present time. The erosion of the weak marls and clays of the Severn valley has led to the wearing back of the escarpment, and also to its breaching by streams flowing down the scarp into the low Severn valley. These streams run in an opposite direction to the original “consequent” streams of the dip slope, and are therefore termed “obsequent.” Since they flow from a high to a low level in a few miles, they are rapid and have eroded deep, gorge-like valleys, which in some cases have cut far back into, or even through, the plateau; the Bristol Avon and the Frome are the largest of these obsequent streams in the Cotswold area.

A few miles north-east of its highest part, the escarpment is broken by a marked embayment (south of Stratford-on-Avon), where low ground is floored by Lias clay. In this indentation is a village whose name, “Moreton-in-Marsh,” indicates its situation in marked contrast to a neighbouring plateau village, “Stow-on-the-Wold.” Immediately south of Moreton-in-Marsh, a hollow in the plateau is drained southward by the Evenlode tributary of the Thames, and this break marks the end of the Cotswold part of the limestone belt.

North-eastward the plateau is lower and the escarpment, here known as Edge Hill, is formed of a bed of limestone, the marlstone, which occurs among the Lias clays; it is called the Middle Lias Marlstone by geologists; and consequently the escarpment is not here “oolitic.”

To the north-east again the limestone belt is broken by the Cherwell valley, and as it is followed still farther it becomes gradually lower. One part of this limestone area is sometimes

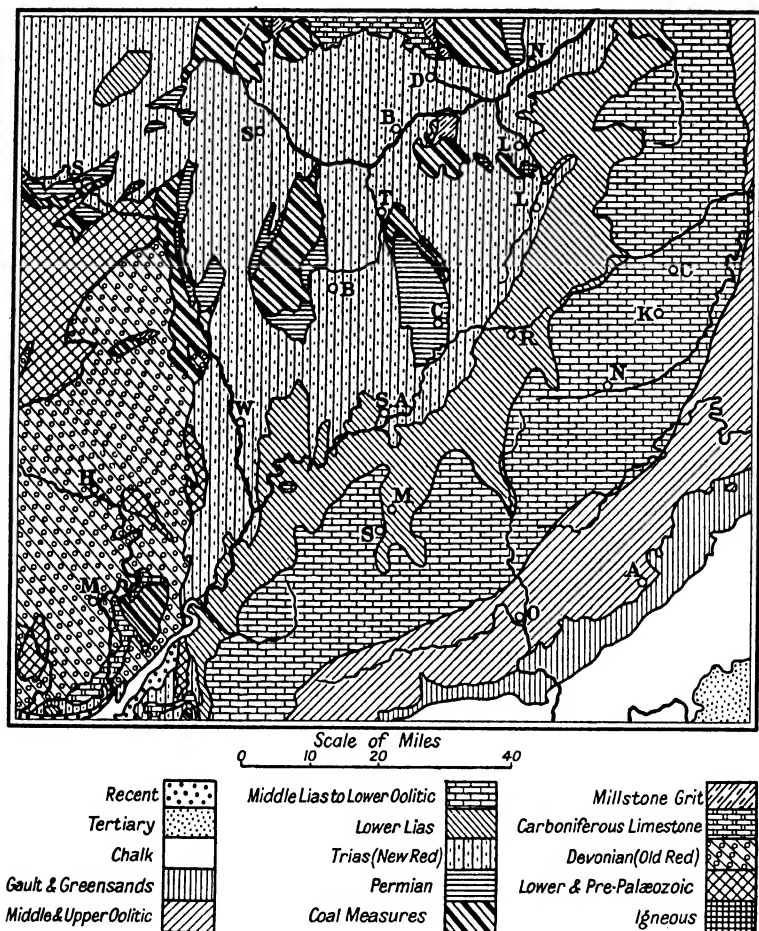


FIG. 25.—GEOLOGY OF THE MIDLANDS.

Note that the small area shown as Coal Measures immediately south-west of Loughborough should have been marked as part of the igneous rocks of Charnwood Forest.

known as the Northampton Uplands,¹ but the escarpment is in parts imperceptible and within the belt there are broad, low valleys. In this part the region is mainly drained to the Wash, by the Rivers Ouse, Nen and Welland. In the counties of

¹ The term "Upland" is best reserved for much higher areas in the north and west of Britain. It would bring English usage more into agreement with that of other countries if the following scheme were adopted: lowlands are areas generally not exceeding 1,000 ft.; uplands have considerable areas between 1,000 and 3,000 ft.; highlands have considerable areas above 3,000 ft.

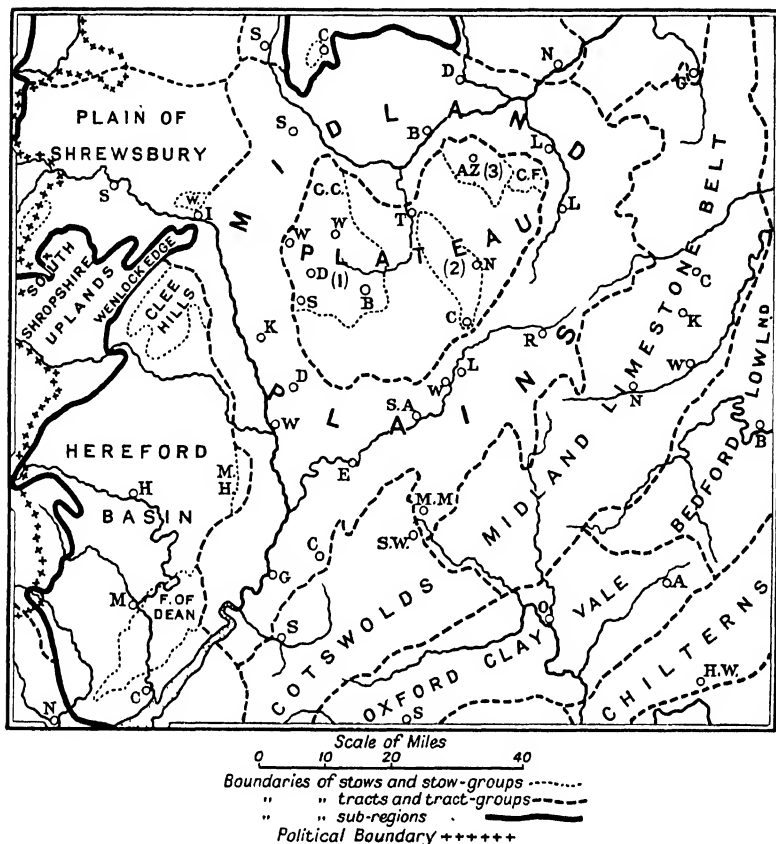


FIG. 26.—REGIONS OF THE MIDLANDS.

Northamptonshire and Rutland clays underlie the surface over a considerable part of the belt and glacial deposits give a further variety. Mixed farming is carried on and cattle rearing becomes important. The cattle, however, are not kept primarily for dairying, but for providing beef and leather, and the latter was one factor in aiding the growth of boot and shoe manufacturing at Northampton, Kettering and other towns.

In the same part of the limestone belt, iron ores are found and largely worked. The Lias and Oolitic beds provide about 90 per cent. of the iron ore obtained in Britain, though as the amount of iron in this ore is less than in the deposits found farther west, their value is not as great as this percentage

suggests. On the other hand, the ores occur relatively near the surface and in thick beds, so that they can usually be quarried and not mined. The southern part of the Jurassic belt produces but little ; the greatest amount comes from this Midland portion and especially from the neighbourhood of Wellingborough and Kettering. At these places and at Corby, a few miles to the north, there are blast furnaces for obtaining pig-iron and steel, much of which is sent to the " Black Country " for working up into steel goods.

In the east of Leicester and in the south of Lincolnshire, the marlstone again forms an escarpment, though it is low. Farther north the belt becomes still lower and assumes a northerly direction ; this section of the region will be treated in connexion with the rest of Lincolnshire in the chapter on Eastern England.

The Midland Plains.—We now turn to consider this great area in its various parts. Immediately beneath the limestone escarpment the low country is underlain by the Lias clays, but farther to the west their place is taken by the New Red marls and sandstones. Broadly speaking, these formations have been worn down to form the lowland which centres in the neighbourhood of Birmingham and stretches thence in three main directions : one to the south-west, drained by the lower Severn and its tributaries ; a second to the north-west, drained by the middle Severn ; and a third to the north-east drained by the Trent.

This plain is diversified, however, by other structures. In the first place there are belts of sandstone which are more porous and resistant to erosion than the marls and clays among which they are interbedded ; consequently these sandstones form ridges which differ from the wetter and lower portions in much the same way as has already been indicated in connexion with the sandstones of Southern England.

A more important geological feature is, however, the emergence of older rocks through the New Red layers. Among these older rocks are some of Carboniferous date, consisting mainly of Coal Measures containing workable seams of coal. The occurrence of the coal measures has led to the mining and industrial developments of the Midland coalfields, which have transformed considerable areas. These form part of the central area known as the Midland Plateau which differs in several respects from the surrounding country.

We will first consider the Midland Plains. In the south, the

Vale of Gloucester, between the Cotswolds and the plateau of the Forest of Dean, is a very productive region, where dairy farming characterizes the lower lands of clay and river alluvium, and fruit growing and market gardening the higher areas of rich loamy soil of the marls. Gloucester is an ancient cathedral city, important as a centre of routes in the West Country, for it is at the lowest road-crossing of the Severn, although between Gloucester and Bristol railways now utilize a bridge and the Severn Tunnel. Moreover, the Severn was navigable for small boats as far as Gloucester. Also, a canal has been cut through the lowland on the left bank of the river to avoid the shallow meanders below the city. Another difficulty for shipping is the tidal bore, the advancing "wall" of water which is formed as the tidal current is confined in the narrowing and shallowing mouth of the Severn. The canal continues above Gloucester to Worcester and Birmingham. Near Gloucester, and immediately under the Cotswold scarp, is Cheltenham Spa, a large residential centre.

At Tewkesbury the Severn is joined by its tributary the Avon, known as the Warwickshire Avon because its upper course traverses that county. The lower part of the Avon Valley is called the *Vale of Evesham*, a wide area worn down in the Lias clay. Although glaciation has directly influenced, by the deposit of boulder clay and sands, only the northern part of the Midlands, indirect effects have followed in the lower part of the Severn basin. This is exemplified by the southward working of glacial sands by post-glacial streams into the Vale of Evesham, where broad terraces of lighter material now lie over the heavier clays. Thus the soils are unusually fertile, and the region is an area of intensive market gardening and an orchard country particularly famous for plums.

A little higher upstream is Stratford-on-Avon, the birthplace of Shakespeare and the site of the Memorial Theatre, and above this town are Warwick and the adjoining health resort, Leamington. Near the head-waters of the river stands the railway junction of Rugby, where good communications have allowed heavy, as well as light, engineering works to flourish some distance from coal and raw materials.

Continuing the direction of the upper Avon to the north-east, the Lias and New Red plain is drained to the Humber, first by the Soar, a tributary of the Trent, and then by the main stream of

that river. In the *Soar Basin* the marls and clays provide wide stretches of pasturage for cattle, kept mainly for beef and hides, but also for dairying and the making of Stilton cheese. Moreover, glaciation has left gravels and sands which lighten the soil and aid arable farming, together with chalky boulder clay which produces a "wold" type of country. At Leicester on the Soar, a borough with a quarter of a million inhabitants, there is a wool-spinning industry which dates back many centuries, and associated with this is the making of hosiery. Leicester is also an important centre of boot and shoe manufacture, and the source of most of the machinery used in that industry in England; some of the leather is obtained locally, and the Leicestershire coalfield is not far to the west.

Loughborough, farther down the valley, is another centre of hosiery making, and the site of a large electrical engineering works.

The *Upper Trent Valley* above the junction of that river with the Soar runs in a general west-to-east direction and forms the northern part of the Midland Plains in the counties of Staffordshire and Derbyshire. This country, which is situated between the uplands of the Pennines on the north and the Midland Plateau on the south, resembles the Leicestershire area just described, for its low relief and fertile soils have developed upon layers of the New Red marls. These are cut into by the Trent and its tributaries, which have fairly broad flood-plains of alluvium. Both on these and on the grass-lands of the marly soils, the farmers give much of their attention to the rearing and fattening of beef cattle. The town of Derby is situated on a tributary of the Trent, the Derwent, where it debouches upon the Midland Plains after leaving its valley in the Pennines; the York, Derby and Nottingham coalfield extends to within a few miles of Derby, and its proximity has aided the establishment at this town of the chief construction and repair shops of the Midland Railway and of motor-car works. Higher up the Trent valley is Burton-on-Trent, famous for its brewing; here, and at other towns in the valley, the success of the brewing industry is in part due to the fact that the well-water is of a peculiarly suitable kind of "hardness" due to beds of gypsum found in the New Red marls. The occurrence of gypsum (hydrous calcium sulphate) is frequently of geographical significance; in this region it is also quarried for making plaster of Paris, while

farther up the course of the Trent it is used for moulds for the pottery industry.

The pottery industry, however, is carried on outside the region we are now considering, as it is in north Staffordshire on the coalfield situated on the south-western flank of the Pennines. The town of Stafford is at the western end of the lowland part of the Trent basin, and is a rather important railway junction.

The Middle Severn Valley.—West of Stafford is the basin of the Severn, the middle part of whose valley forms the western arm of the Midland Plains. At Ironbridge, a dozen miles below Shrewsbury, the river cuts a gorge between the long line of Wenlock Edge and the wooded heights of the Wrekin, rising to over 1,300 feet. These heights, and the higher Clee Hills a few miles to the south, are exclaves of the South Shropshire Uplands, an extension of the Welsh Highland, thrusting north-eastward towards Stafford and forming a barrier between the basins of the upper and middle Severn. On the upper side of this barrier is the Plain of Shrewsbury, which passes without essential change into the Plain of Cheshire and so forms part of North-western England. On the lower side of the barrier the valley of the Severn is at first rather narrow, cut into undulating country of moderate elevation and diversified with much woodland. The geological map shows that in this part of its course the river skirts the small Shropshire coalfield where the Carboniferous rocks rise from beneath the New Red layers of the plain and are bent up westward against the still more deeply seated rocks which form the South Shropshire Uplands. On this coalfield there has been little industrial development, though the town of Ironbridge takes its name from the fact that here the bridge over the Severn was the first to be made of iron, and Kidderminster, a few miles from the river, has been able to maintain carpet making, which began before the Industrial Revolution.

Near Kidderminster, the Severn valley opens out to the *Plain of Worcester*, underlain by New Red marls and sands, much of it level and forming a very productive area. In the lower lands by the Severn, and more widely distributed in the north, there are vegetable gardens for the supply of the adjoining industrial areas of the Midland Plateau; orchards are important over much of the region and particularly in the area lying in the shelter of the western boundary uplands; most wide-spread

are the grass-lands which support great numbers of cattle, both for beef and also for milk and other dairy products. At Droitwich, in the north of the plain, salt is got from brine pumped from beds of rock-salt which are found in the New Red marls, and porcelain of high quality is made at Worcester, the natural centre of the plain and the site of an old cathedral.

The Midland Plateau.—This higher, heart-shaped area is situated in the centre of the Midland Plains. Its plateau form has been largely modified where, in the middle of the area, the Tame and its tributaries have worn a wide valley leading northward to the Trent. Most of this hollow consists of New Red marls, sandstones and clays, and in its general appearance and utilization it resembles the New Red valleys which surround the plateau; it must be noted, however, that glacial deposits cover considerable areas, and as elsewhere glacial gravels above the heavier marls and clays have encouraged settlements by improving the drainage and the water supply.

What gives special importance to the Midland Plateau is the emergence of older rocks from beneath the New Red deposits to form areas differing in elevation, scenery and utilization from most of the Midland Plains (see Fig. 27).

The South Staffordshire Industrial Region.—The plateau rises westward from the lower valley of the Tame, and stretches from Cannock Chase, adjoining the Trent in the north, to the Clent and Lickey Hills in the south. In this area a horst, detached by faults from the deep-seated, underlying platform of rock, has been thrust up through the cover of sands and marls. The block is itself much faulted and consists of various materials of different ages. Much of it belongs to the Coal Measures, parts are of Permian and New Red date, while masses of igneous rock (too small to show on the geological map in Fig. 25) have intruded among the rest. The composition of the layers also varies and gives complexity to the area; in the extreme north pebbly New Red beds form barren heaths in Cannock Chase, which reaches 700 feet in height; in the south the Clent Hills and the Lickey Hills rise to about 1,000 feet; between these extremes and just west of Birmingham, intrusive basalt stands up boldly to nearly 900 feet. The most important effect of the structure, however, is the occurrence of workable coal near the surface, and this has led to the development of the South Staffordshire coalfield.

There is a difference, moreover, between the northern and southern parts of the coalfield. In the Cannock Chase area the seams of coal are thin and separated, while in the part west of Birmingham there is the famous "Ten Yard Coal," which was early worked and above which the "Black Country" developed. An important factor in the growth of the industry in this region was the occurrence in the Coal Measures of the "clay iron-stone" or "black-band" iron ore; this was early worked at several centres in this district, even before coal took the place in smelting of charcoal obtained from the forests which once covered much of this country.

Among the early industrial towns were Birmingham, Walsall, Wolverhampton and Dudley, whose positions roughly mark out the limits of the Black Country. Birmingham is just beyond the eastern margin of the coal-mining area, where a belt of sandstone a few miles south of the marshy Tame valley gave a convenient site for a trading centre. The traffic which was first carried by roads was later aided by the construction of a network of canals joining Birmingham to all parts of the district and linking up by the Grand Union Canal through Northampton to the Thames, by other waterways to the Severn, and by the "Trent and Mersey Canal" to the great ports and industrial areas of Yorkshire and Lancashire. Railways, too, have been constructed from all parts to Birmingham.

This development in communications followed the utilization of the coal resources, for it was the close proximity of the coal, the iron ore, and limestone from some of the ancient rocks, which led to the great development of the iron industry and transformed a rural area into the Black Country. The iron supplied the raw material for a great variety of iron and steel products, while brass and copper goods were also made. Blast furnaces, steel mills, factories and workshops of innumerable kinds were surrounded by masses of small, closely packed little houses for the workers, and a number of large towns grew up and formed the great conurbation of which Birmingham became the commercial and industrial "capital."

During the nineteenth century the region was appropriately called the Black Country, for there was little vegetation left even in the country which was not covered by buildings.

Marked changes have recently occurred, however, in the nature of the work and even in the appearance of the region.

One reason is that the iron and the coal of the district have been largely exhausted, and the blast furnaces have almost disappeared ; iron and steel have therefore to be obtained from other parts, e.g. from the oolitic limestone belt to the east and from South Wales. Another reason for the change is the situation of the coalfield ; it is far from any port, and is therefore handicapped in exporting its goods, particularly those of a bulky character. The consequence is that the " heavy " industry has largely gone, and the work is changing over to the production of smaller goods and those which combine metal with other components, as in bicycles and motor-cars, electrical apparatus and tools, together with a great variety of other commodities, e.g. artificial silk, clothing, rubber goods and prepared foods and confectionery. This is not a simple case of " geographical inertia," as would be the continuance of the iron and steel industry when its original causes disappeared, but rather a case of " transferred inertia," the experience and skill of the people, and often the buildings and equipment, being adapted to meet new conditions.

Moreover, the smokiness of the area has been reduced; the slag-heaps and spoil-banks of the iron furnaces and coal-mines have been in part cleared away and replaced by allotments; the slums have given place to healthier residential districts, and the formerly congested central part of Birmingham has been converted to an area of wide streets and fine buildings. One may perhaps say that in these changes now proceeding in the kind of work and the condition of the towns, the Black Country is typical of British industry in general.

While adapting its activities to changing circumstances, this region has been able to increase its population almost as markedly as the London region, for the census of 1931 showed that its rate of growth during the preceding ten years was over 8 per cent. The whole conurbation has nearly two million inhabitants ; in Warwickshire it includes Birmingham itself with nearly one million people, and it reaches out in South Staffordshire to the north-west to embrace Smethwick, West Bromwich, Wednesbury, Walsall and Wolverhampton, while to the west it extends to Dudley and Stourbridge in Worcestershire. The Birmingham water supply has to be obtained from the basin of the Upper Wye in Wales, through an aqueduct 100 miles long.

With the exhaustion of the more accessible seams of coal in

the central part of the coalfield, mining has spread to the coal-measures which lie at greater depths beyond the horst, i.e. below the surrounding New Red layers. Coal is therefore obtained outside the limits of the area shown as "Carboniferous" on the geological map, especially on the eastern side near Birmingham, and most of the mining now goes on outside the industrial conurbation.

The chief mining development has taken place in the previously neglected part of the South Staffordshire coalfield in the Cannock Chase area, whence the greater part of the coal now comes; the total amount, however, is not great, for, judged by its output, this is now one of the small British coalfields. The coal is not used in the Cannock Chase area, but sent away; as there is good "house-coal" in these seams, much is carried by rail to London and other parts of Southern England.

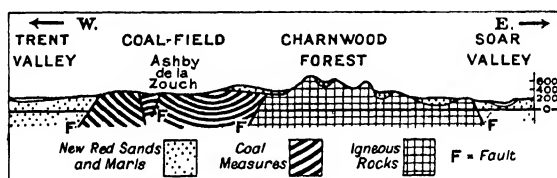


FIG. 27.—SECTION THROUGH LEICESTERSHIRE COALFIELD AND CHARNWOOD FOREST.

The area shown on the regional map as the South Staffordshire mining and industrial region (1) includes the great conurbation and all the districts from which coal is actually obtained, e.g. the purely mining area of Cannock Chase in the north.

The East Warwickshire Industrial Region.—On the east side of the lower Tame valley the coal-bearing strata again emerge and form a belt running south-eastward from Tamworth past Nuneaton almost as far as Coventry. This belt forms the East Warwickshire coalfield, from which still less coal is obtained than from the South Staffordshire coalfield, and which has not given rise to such an important manufacturing region. Most of the coal is sent away for industrial and domestic use, and the largest town dependent upon the coalfield is Coventry, situated just south of the mining area. Here, as in the Black Country, a continued growth has been made possible by marked changes

in the form of the industry : the early textile-making gave place to the manufacture first of bicycles and then of motors ; recently artificial silk has been added. The whole coal-mining and industrial region is marked (2) on the regional map.

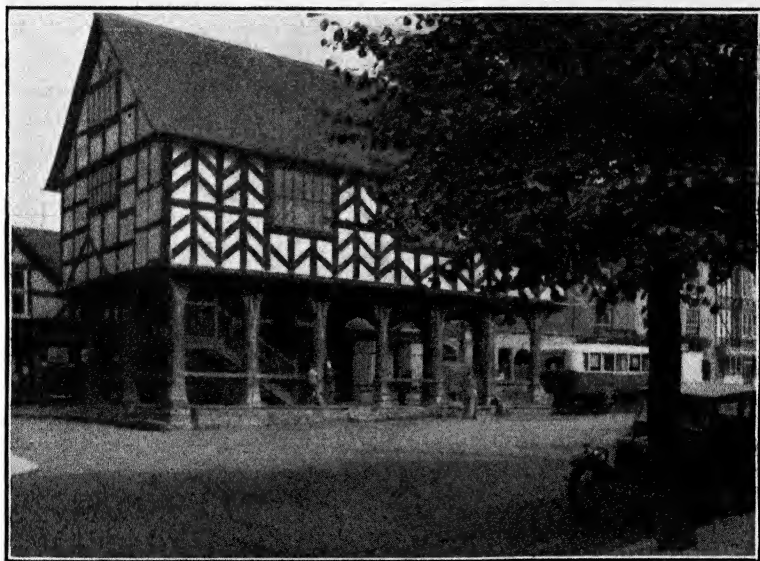
The Leicestershire Coalfield.—To the north-east rises another mass of older rocks through the New Red surface deposits, and here is the Leicestershire coalfield, the last of the Midland series. It is another small coalfield, though its productive area, marked (3) on the regional map, extends below the younger rocks south-east of the carboniferous limit as shown on the geological map ; it is remarkable in that the coal is not utilized to any extent in the neighbourhood, and illustrates the fact that industrial development does not necessarily occur upon a coalfield ; it is sometimes called after the small town of Ashby-de-la-Zouch.

Adjoining this region on the east, a still greater dislocation of the strata has brought up a mass of very deep-seated, ancient and resistant rock, mainly of igneous origin. This forms an island, as it were, of irregular upland, at one point reaching 900 feet in height west of the curve of the Soar valley between Leicester and Loughborough ; it is known as *Charnwood Forest* and is still wooded in part. The higher ridges stand up as barren moorlands, there are great quarries yielding granite, there are woods on the lower slopes, and the impermeable rock holds up water stored in lake-like reservoirs constructed by damming up some of the valleys. These features allow us to regard Charnwood Forest as an isolated stow akin to the western upland regions of England and Wales. Because of the emergence, in the Midland Plateau, of the older rocks through the younger layers and the consequent contrasts in the geography, the Midland Plateau is an example of a composite tract.

The Hereford Basin.—It is convenient now to consider the area which is situated between the Midland Plains and the Welsh Upland, consisting of the regions drained mainly by the lower Wye and Usk after these rivers have descended from the mountains of Wales.

A few miles west of the Severn below Worcester, there rise steeply from the plain the *Malvern Hills*. This narrow ridge is formed by the emergence of a belt of resistant material largely formed of gneiss and of other ancient rocks known to geologists as of Archæan and early Palæozoic age. These rocks are akin

to those of the Welsh Upland, and form the eastern rim of a great basin dipping from Wales below the somewhat younger layers of the Hereford Basin and rising again in the Malverns (see Fig. 22). This ridge, with its vegetation covering consisting of little more than short turf and occasional low shrubs, except for the woods on the lower slopes, may be regarded as a small exclave of the Welsh Upland. The eastern side is almost precipitous, for it has been formed by great faults which have let down the ancient rocks below the younger deposits of the Midlands.



[Judges' Ltd.]

FIG. 28.—VIEW OF THE MARKET-HOUSE AT LEDBURY.

Built over 300 years ago, this is a fine example of the timbered houses of the West of England; it is supported on massive pillars of oak.

In the *Hereford Basin* between Wales and the Malverns, the Archæan and early Palæozoic rocks are covered by deposits of Old Red Sandstones (of Devonian, or middle-Palæozoic, age). These sandstones, however, are of varying powers of resistance, and while they form relatively low country in the Hereford region, they are raised to mountainous height farther west and form part of the Welsh Upland.

The commonly used term "Plain of Hereford" may be misleading, for the country is by no means level. An observer standing on the Malvern Ridge at a height of nearly 1,400 feet

is struck by the difference between the flat, intensely cultivated plain of the Severn on the east, at an elevation which does not vary much above or below 100 feet, and the uneven country on the west, with lines of wooded hills frequently rising 500 or 600 feet, or even more, above the cultivated river valleys. The Hereford region is best considered as an upland basin deeply dissected by the Wye and its tributaries, and in the north by tributaries of the Severn.

The "Old Red Sandstone" system of the geologists includes in this region extensive beds of marls, and the rocks generally weather to a fertile soil; hence the lower lands of Herefordshire, like the Vales of Worcester and Evesham, are noted for the growing of apples, pears and other fruits; also, the county of Hereford ranks next to Kent in its production of hops, and there are considerable numbers of the well-known Hereford cattle. The limits of the county almost correspond with those of the geographical region, and the city of Hereford is the natural centre of both. This basin, like the neighbouring plain of the Severn, shows many traces of agricultural prosperity dating back for centuries, for Hereford, like Worcester and Gloucester, has a fine cathedral, and throughout this western country there are beautiful old half-timbered houses, while in many towns there still remain the ancient cloth-halls or town-halls in the market-places.

The southern limit of the Hereford Basin is formed by the upland known as the *Forest of Dean*. This is a plateau, the remaining part of an uplifted peneplain; its edges rise over 800 feet above the Severn valley on the east and the valley of the Usk on the west. The River Wye flows from the relatively low Hereford Basin to the northern edge of this plateau, of which, indeed, it seems to take no account, for between Ross and Monmouth its meanders are in several cases partly on the lower land and partly cut into the edge of the upland; between Monmouth and Chepstow the plateau is bisected by the deeply incised meanders. These facts indicate that the river took its course before the development of the surface of the land as we see it to-day, and the meanders originated at a time when the surface of the Hereford Basin was flush with the surface of the plateau; since then the river has maintained its old course, but the softer Old Red sandstones and marls of the plain have been widely worn down, while the plateau has been little dissected except

where cut by the stream itself. Thus the river has been "super-imposed" upon the present relief.

The plateau is resistant because it is a syncline formed of hard sandstone and carboniferous limestone on the margins and coal-measures in the centre. The coalfield is one of the smallest in Britain; the coal is mainly sent away, and the thin woods of oak which still cover much of the plateau hide the small and scattered evidences of the mining.

From the point of view of physical geography the area around the mouth of the Usk may be regarded as an extension of the plain of the Severn, but this coastal area is so closely connected with the South Wales coalfield that it will be best to consider it with that region in a later chapter.

With the Upland exclave of the Cleve Hills in the north, the upthrust of the Malvern Hills on the east, and the coal-bearing plateau of the Forest of Dean in the south—all contrasting with the lower central area—the Hereford Basin forms a tract of markedly composite character.

CHAPTER VII

EASTERN ENGLAND

East Anglia.—This tract is situated east of the long hollow occupied successively by the Clay Vale drained by the upper Great Ouse, the Fenlands and the Wash. To the south, East Anglia is bordered by the London Basin, from which it may be distinguished by its almost complete cover of glacial clays, loams and sands.

Beneath this cover in the west is the chalk whose western edge may be taken as the landward boundary of East Anglia, except where in Norfolk the Lower Greensand outcrops from beneath it and forms the margin of the moderately high land overlooking the Wash and the lowest course of the Ouse. From the western edge the chalk sheet dips eastward in Norfolk and south-eastward in Suffolk and Essex.

In the south of East Anglia, the chalk dips below the lower London sands and the London clay of Tertiary date, but in the eastern part of Suffolk and Norfolk the chalk is generally covered by later Tertiary deposits of sandy and shelly material known as "crag." The geological map in Fig. 29 indicates this "solid" geological structure, but the "drift" of glacial origin overlies practically all the other formations, and is of very great importance.

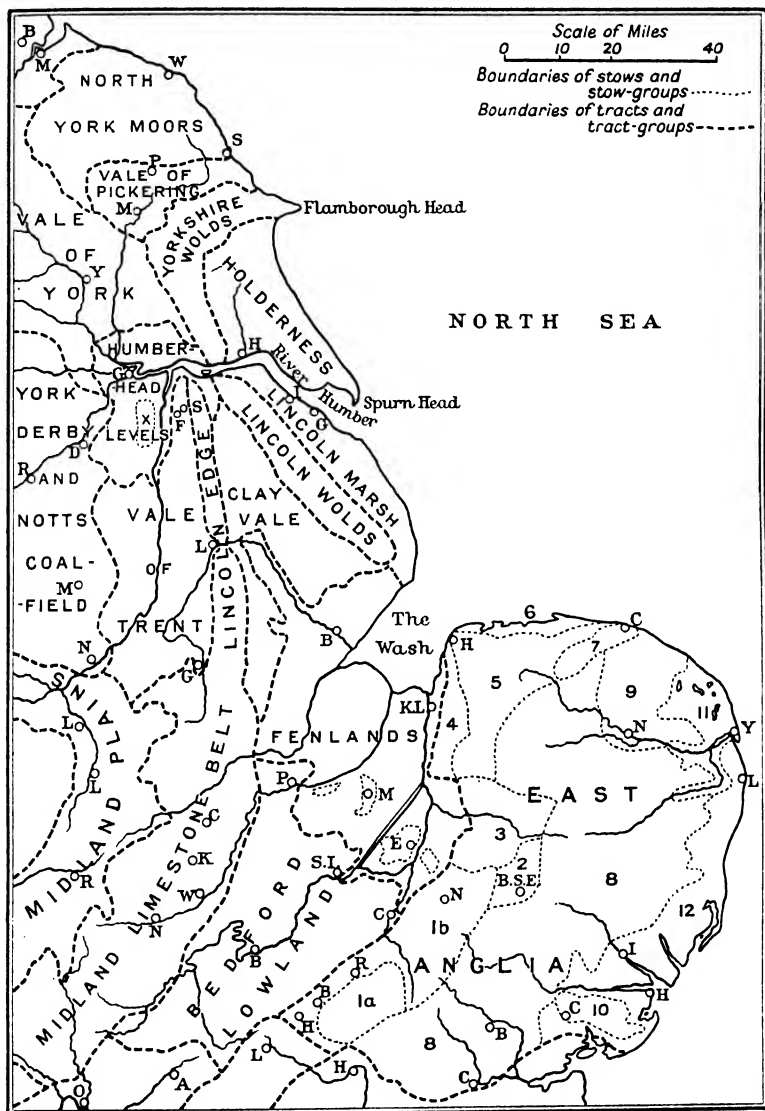
We will begin our study of East Anglia by considering the *Chalk Downland* (1a and 1b on the regional map), which continues the line of the Chilterns to the north-east. Here the ice-sheet from the north overrode the chalk plateau, scraping away great amounts of chalk and carrying them in the "chalky boulder clay" to central Essex. The chalk region itself was much influenced: for one thing, the western face of the chalk was worn back, and the escarpment which stands up as a feature of the landscape as far along the Chilterns as the Hitchin Gap is no longer to be seen so clearly. There is rather a series of irregular steps of broken outline, the most marked rise being set back some miles south-eastward from the edge of the chalk outcrop to the neighbourhood of the small towns Baldock and

Royston. In front of this rise, the lower chalk marl is exposed and forms a belt of low, fertile country, rather like that referred to in Chapter II as situated in front of the South Downs, and similar to others occurring elsewhere on the margin of chalk scarps in Southern England. In East Anglia, this low chalk belt extends from the Hitchin Gap north-eastward past Cambridge to near Newmarket.

The term *East Anglian Heights* is rather loosely applied to the higher country of the western part of East Anglia, but if we are to think of the East Anglian Heights as a chalk plateau, we must restrict the name to the belt (1a) with the marked rise overlooking Baldock and Royston. This belt begins at the Hitchin Gap and stretches north-eastward as far as the valley of the Cam, which crosses the chalk in a northward direction to leave it close to Cambridge. Beyond the Cam valley the chalk does not form a plateau, for the whole sheet sags down towards the area (known as the Breckland—3 on the map) at which it is crossed by the Little Ouse and where it has no longer any of the features we regard as characteristic of this formation.

There are therefore two regions of chalk downland in East Anglia : (1) the smaller is the plateau, with an average elevation of about 400 feet ; this forms the East Anglian Heights (in the restricted sense in which we use the name) between the Hitchin Gap and the Cam valley, (2) the larger region is the lowland (1b), consisting of the chalk-marl belt in front of the Heights and the wider belt which prolongs the line of the Heights beyond the Cam valley as far as the Breckland.

The strip of chalk marl along the western edge of the belt is naturally fertile, and the ice-sheet deposited upon the remainder of the belt, both " high " and " low," the chalky boulder clay which forms a loamy soil well adapted to arable farming. Consequently both the East Anglian Heights and the less elevated chalk downland are productive areas given over mainly to the growing of wheat and barley, together with root-crops and grasses for the feeding of sheep. The type of farming somewhat resembles that described as carried on in the chalk lands south of the Thames, but the cover of boulder clay has enabled the proportion of arable land to be much greater. The amount of cereals produced here is very considerable ; indeed, East Anglia as a whole stands out as being *the* barley-producing region of the British Isles, for this crop is well adapted both to the



area of light, loamy soil (2) which adjoins the north-east corner of the downland region, in the neighbourhood of Bury St. Edmunds, and is specially used for the fattening of sheep and lambs.

The Breckland (3) is a markedly contrasted region situated where the chalk edge turns from its north-easterly direction in Suffolk to its northerly direction in Norfolk, and here the sheet sags down so that there is no escarpment and the country is indeed lower than that to the east. It is drained westward to the Great Ouse, and the largest stream is the Little Ouse, an obsequent river which has cut far back into the low plateau of East Anglia. In this Breckland hollow, in the Ice Age, streams from the melted ice covered the chalk with glacial sands and gravels from which has formed a markedly dry and infertile soil. There are large areas characteristically named "Warrens," and numerous reed-skirted pools are the haunt of wild-fowl, but there are some districts of greater productivity, and in recent years two developments occurred, viz. the growing of beet for sugar and the afforestation of previously unused land.

North of the Breckland, the *Greensand Belt* (4) forms the western edge of the low plateau, descending to the Fenlands by irregularly cut valleys in which cattle farming is carried on, and with the slopes and ridges often occupied by heaths and woods.

Behind this belt the country rises to the *North-west Norfolk Plateau* (5), which has an average elevation of between 200 and 300 feet. The subsoil is chalk, but it is usually masked by glacial sands; the chalk is, however, to be seen in the cliffs which form the north-western corner of Norfolk at Hunstanton. The sands give the region a rather poor soil, but here man's intelligence and industry have overcome natural obstacles, for in the eighteenth century landowners of this area initiated the development which is sometimes called the Agrarian Revolution, and made possible the supply of food for the greatly increased number of workers of the Industrial Revolution of the same period. This was done by adapting the agricultural methods of the countries across the North Sea: root-crops and clover were grown in turn with grain-crops, thus giving a rotation which both maintained the fertility of the soil and also provided food in summer and in winter alike for great numbers of stock. Thus what had been poor country became, and has remained, a productive arable and sheep-raising region.

The northern edge of this low plateau dips down to the *North Norfolk Marsh* (6), a narrow strip of alluvium behind the north coast of the county. Here rich pastures have been formed, to

which the sheep of the neighbouring plateau are sent for fattening in summer. Both in its physical and in its economic functioning, this region closely resembles Romney Marsh.

A few miles east of the marshes, the coast rises to low cliffs near the pleasure resort of Cromer. These cliffs represent the seaward end of the *Cromer Ridge* (7), a direct legacy of the ice-sheet, for it is a morainic mass which has much gravel, but is of characteristically varied composition and fertility and of equally varied relief. It stretches for more than a dozen miles south-west of Cromer, and rises to heights of over 300 feet.

The central belt of East Anglia, extending from the Cromer Ridge in the north to the London Basin in the south, is formed of the low *Boulder-clay Plateau* (8). Since there is often much chalk and sandy material intermixed with the clay, the soil is by no means as difficult to work as the unglaciated clays of Southern England. Where in Essex the ice-sheet lightened the soil by the addition of much chalk, farming has been relatively easy and remunerative; in the northern part of Suffolk (east of the Breckland) the clay is rather wetter and heavier; in Norfolk the soil is again lighter. There are other differences, but on the whole it may be said that this plateau is a region of mixed farming, producing a fair amount of wheat and still more barley. Cattle, too, are kept in fair numbers, not for dairy purposes but for winter fattening on hay and root-crops from the arable land (together with imported food, such as oil-cake) and for sale in the spring.

The whole of western and central East Anglia, as hitherto described, will be seen to have no natural resources which would attract or support a large number of people. It is an agricultural region with but a moderate density of population at the most; there are a number of country markets distributed fairly evenly over the area, but no large towns or cities. The only exceptions to these generalizations are in Essex on the main routes from the metropolitan area; here Chelmsford, where the Roman road in East Anglia crossed the Chelmer, has some engineering and electrical works, and at Braintree and neighbouring places the artificial silk manufacture has recently developed.

The greatest variety of conditions and the greatest possibility of developments exist in the eastern coastal regions of East Anglia. In the north-eastern corner is the *Norfolk Loam Region* (9), where above the "crag," glacial brick-earth and

loam give an exceptionally fertile soil which has characteristics like those of the loess, usually associated with the continent of Europe. Similar soils are found over smaller areas along the eastern side of East Anglia and particularly in the *Colchester Peninsula* (10) between the estuaries of the Colne and Stour. These areas have a relatively dense agricultural population; the Norfolk Loam Region has the typical Norfolk productions of barley, wheat and cattle, and the Colchester Peninsula resembles it in this respect and also grows vegetables for the populations of London and the Thames estuary regions.

In the southern part of the Norfolk Loam Region is situated Norwich, a cathedral city and the largest centre in East Anglia. It owed its importance in the past to its site at what was once the head of navigation of the River Wensum just above its junction with the Yare, and to its position in the centre of a district productive in agriculture and for long the most important manufacturing area of England. Its worsted industry has disappeared, but the city has retained the manufacture of boots and shoes, and the local production of barley has aided its making of malt vinegar, while mustard from crops grown in the Fenlands is also made at this centre.

Between Norwich and the sea, the River Yare meanders sluggishly through the flat *Broads* region (11). The lower courses of this river and neighbouring streams were once estuaries like those of the southern rivers of East Anglia to-day, for the coast of all this part of England suffered a post-glacial subsidence. Since that time, however, the sea has tended to straighten the coast-line by wearing away the cliffs and projections, especially in the north-west of East Anglia, dragging the material southwards and depositing it at the mouths of the estuaries, while in several places strong winds from the North Sea have bordered the coast by high sand-dunes. Behind the sea-built bars, the rivers have partially or entirely filled the estuaries with alluvium. In the *Broads* region this work is incomplete, and the flood-plains of what were formerly wide and branching estuaries have still great marshes and the reed-fringed lakes known as "broads." These attract holiday-makers, and so does the fishing port of Yarmouth.

The *South-Eastern Coast Lands* (12) are formed mainly of glacial sands and loams above the crag; the soils are often sandy, but their fertility varies, and arable land and pasture

alternate with heaths and commons. They are crossed in the north by low alluvial valleys, and in the south by estuaries which have given opportunities for the growth of several towns. In the north, Lowestoft may be considered a sister-town to Yarmouth, as sharing in the influx of summer holiday-makers to the coast and in the fishing which occurs in autumn. The Dogger Bank and other shallows of the North Sea are the feeding grounds of great shoals of herring ; these spawn earlier in the northern areas than in the southern, and consequently the fishermen work southward. In autumn Scotch boats as well as local ones fish off Yarmouth and Lowestoft, and a large number of Scotswomen arrive to clean, salt and pack the herring for export.

Ipswich, at the head of the Orwell estuary, is the largest town in Suffolk and the chief centre in East Anglia for the making of agricultural machinery and implements ; this industry affords a parallel, in its situation and the factors affecting its development, to that carried on at Rochester. At Ipswich are also made fertilizers used in the East Anglian agriculture, the work being originally based on local minerals found in the crag, though it is now carried on with imported materials. Malting from barley is another of the occupations of Ipswich, which illustrate the close relation between agriculture and the small industries of East Anglia. Colchester, some distance up the Colne river, was founded as a Roman station, and now has activities of much the same kind as those of Ipswich. At the mouth of the Stour estuary is the port of Harwich, which gives a quick passage from London to Holland and Germany ; to facilitate the crossing a train-ferry has been arranged.

The relatively greater development of this southern part of East Anglia owes much to its position, for this has allowed its harbours and estuaries to remain free from the silt which has blocked the northern coast, while the region is in a closer relationship to the metropolitan area.

The Bedford Lowland.—The broad vale between the Chilterns and the Midland limestone plateau is drained in its south-western part to the Thames, and in its north-eastern part by the Great Ouse and its tributaries to the Wash ; the divide is of morainic origin, and the upper basin of the Ouse is covered to a considerable degree by chalky boulder clay, with patches of glacial gravels and sands. From the water-parting to the

Fenlands the region, to which we give the name of the Bedford Lowland, widens out between the chalk and the limestone, and below the glacial deposits it is formed mainly of longitudinal belts of Gault clay, Lower Greensand and Oxford clay. Although there are higher areas and patches due to the occurrence of morainic material and belts of sandstone, it is in general a lowland descending gradually to the north-east where the country becomes very flat before the firmer soils give place to the alluvium of the Fenlands.

As would be expected, the soils are of varied character ; on the whole, they are rather difficult to work, and in the lower areas drainage has been a difficult process, but farming has proved remunerative, the region is productive and, for an agricultural area, relatively well-populated.

North-eastward from the divide the Bedford Lowland is increasingly utilized for arable farming, while cattle-rearing on open pasture becomes much less important. As the climate becomes drier towards the east so cereals are more grown, and the counties of Bedford, which occupies the central part of the lowland, and Huntingdon and Cambridge, which overlap the region into the Fenlands, have a high proportion of their area given to wheat.

It is on agriculture that the population mainly depends, and the towns are in the main market towns of no great size. Bedford is somewhat exceptional in having engineering works in which pumps, oil-engines, gas-engines, etc., are made ; this industry is made possible by its situation at a railway junction on one of the main lines between London and the Midlands. All the larger settlements, including Bedford, are on the rivers draining to the Wash, and a series of small towns marks the line where these rivers leave the firm ground to enter the once marshy Fenlands : Peterborough is on the Nen, St. Ives is on the Ouse (with Huntingdon a little farther up the valley), and on the Cam is Cambridge, which has grown to be the largest town of the region because of its ancient and great University.

The Fenlands.—That the Fenlands make a geographical unit is obvious ; it is a tract, however, for it contains various areas with distinctive characters. It may be taken as limited in general by the 50-feet contour line, though its average elevation is only about 15 feet above sea-level. Practically all its extent of 1,300 square miles has been reclaimed and transformed

by man, and if London may be regarded as, in one sense, a man-made stow, so the Fenlands may be regarded in the same limited sense as a man-made tract.

Its characteristics may be realized by a short survey of its natural and artificial evolution. On the east of the Wash entry the sheet of chalk is cut short at the Hunstanton cliffs, while on the opposite side of the Wash entry the sheet is found by borings beneath the silt which forms the low coastlands, and a few miles to the north-west the chalk again appears on the surface and rises to form the Lincoln Wolds. These facts are explained if one imagines the chalk sheet dipping from the Lincoln Wolds south-eastward beneath the Wash. There is, indeed, a slight "sag" in all the layers forming the earth's crust beneath the Wash and the Fenlands.

In this "sag" the ice left widespread deposits of boulder clay, which is now found exposed on the landward margins of the Fenlands. Moreover, after a subsidence of the whole area of Eastern England and the North Sea, the waters covered the latter area and penetrated the "sag," drowning not only the Wash but also much of the Fenland. At this stage the boulder clay of all the lower, seaward portions became covered with silt.

After these happenings the history is somewhat similar to that described in connexion with Romney Marsh, for on the seaward side currents and tides deposited marine sands and silts, while on the landward side rivers brought down alluvium. Upon this river alluvium various kinds of vegetation developed, from the remains of which in the course of long ages great masses of peat were formed. This peat now forms the subsoil of an inner belt of the Fenlands, between the boulder clay on the landward margin and the marine sands and silts which occupy the area of the lower courses of the rivers and the shores of the Wash.

At some points, however, the older formations stood up rather higher and were not covered by the peat or silt: they formed "islands" of clay rising from the marshes, and on these grew woods of alders and willows. The clay areas around March and Ely are shown on the geological map. Thus there are at least three types of country within the Fenlands: viz. those of the peat and the silt respectively, and the clay "islands."

Man found this a region of marshes and meres, traversed by sluggish streams which often overflowed and formed great

stretches of water ; the natural vegetation was of sedges, rushes, reeds and water grasses ; there were fish and fowl to be caught, but only on the " islands " could homes be made. Refugees from neighbouring regions sought such places : the story of Hereward illustrates this, and monks withdrew to the isolation of Ely, where their establishment led later to the building of the cathedral which can now be seen for miles across the " Levels."

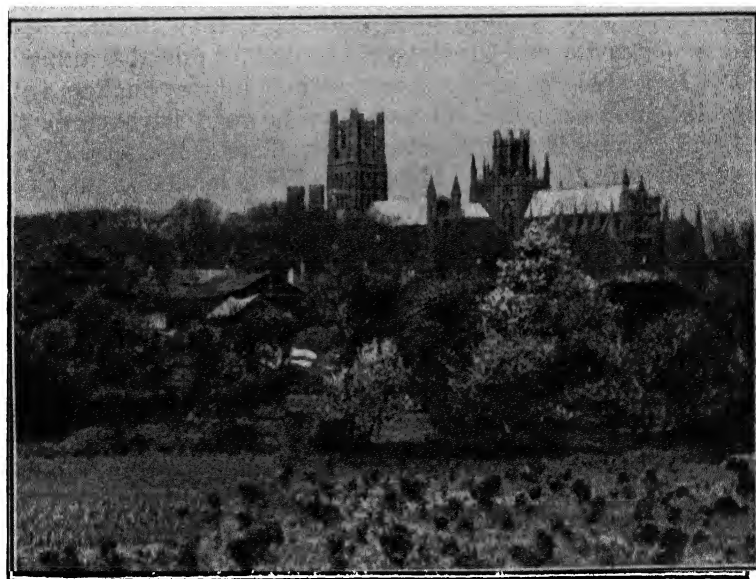
From the islands, the fens were reclaimed ; the low lands were drained by trenches and ditches, the water courses were embanked, and the water pumped from the lower to the higher levels ; the earlier windmills which provided the power for the pumps were later replaced by the less pleasant but more effective steam plants with their high chimneys. The work was at first on a small scale, but in the seventeenth century help was obtained from Dutchmen who had learnt the arts of reclamation in the Netherlands, and at that time the river courses were greatly altered ; atlas maps now show by straight lines the new canal-like courses of the Ouse called the Old and New Bedford rivers, cutting off the great curve below St. Ives, and that of the Nen below Peterborough. In spite of all this work there are times, especially in winter, when inundations turn wide expanses into desolate-looking lakes.

The reclaimed land is rich and allows a very intensive form of agriculture, which has paid for the work involved. Wheat is grown in great amounts, for it is well adapted to the climate of the region ; while the winter is cold, and piercing winds blow with great force over the flat lands, the summers are fairly hot and dry ; the mean annual rainfall is as low as in any part of Britain. Another factor affecting the large proportion of land given to wheat is the relatively heavy soil on which wheat does better than barley ; hence the small amount of barley produced here as compared with East Anglia which, although of similar climate, has lighter soils.

Yet even within the Fenlands conditions vary, and potatoes grow well on the heavier soils above the peat, while on some of the lighter, silty soils such small fruits as strawberries, raspberries and currants are obtained. The fruit growing has led to the manufacture of jam, and since this is a seasonal activity the factories during the remainder of the year make other food-stuffs, e.g. marmalade and custard-powder. Market gardening is another method of intensive and remunerative

utilization of the land. With the assistance of a government subsidy the growing of beet has also been attempted in association with the establishment of sugar factories; this enterprise, like the earlier reclamation, was begun with some Dutch assistance. Some cattle are kept and a considerable number of pigs, but there are scarcely any sheep; the intensive use of arable land is the aim of the farming.

Such work can, and does, support a fairly dense agricultural population. The older settlements were on the higher and



[Judges' Ltd.]

FIG. 31.—VIEW OF ELY CATHEDRAL—A LANDMARK OF THE FENS.

The site is rising ground on the bank of the Ouse, and the tower is over 200 feet high.

gravelly areas, and the peat-lands are generally least densely populated, having a monotonous landscape with a marked absence of trees or even hedgerows; in the reclaimed areas, the roads run straight and the villages at their intersections have a typically rectilinear plan. The larger towns are on the rivers, and near the mouths of the Ouse and Witham respectively are the small ports of King's Lynn and Boston; it may be noted that from these ports, as the nearest to the iron-ore area of Northamptonshire, a considerable amount of pig-iron is exported to Scotland and the Continent.

The Lincolnshire Regions.—Between the Fenlands and the estuary of the Humber the county of Lincolnshire is formed of a series of belts running approximately from S.S.E. to N.N.W., all of which are similar to, or continuations of, regions already described.

The Lincoln Marsh.—A belt nearly 10 miles wide continues some of the characters of silty areas of the Fenland to the southern side of the Humber estuary. It is a flat region floored mainly by marine silts passing inland to a strip of boulder-clay country. The silts have been reclaimed and, like the boulder clay behind, need draining; they provide good pasture for cattle, and the clay area is used for mixed farming.

The low, shallow, sandy shores attract holiday-makers from the Midland towns, but do not provide good harbourage for vessels; fishing is therefore unimportant as a means of livelihood except at Grimsby. Here more fish is landed than at any other British port; the trawlers work not only on the Dogger and other North Sea banks but as far afield as the Iceland and Faroe fishing grounds, and even on the Newfoundland banks and off Southern Europe. They bring cod, haddock, soles, turbot and other varieties of fish, which are sent by rapid railway services to all parts of England.

Railway facilities with the Yorkshire coal-mining and industrial areas have enabled Grimsby to have a considerable commerce with the continent of Europe, importing dairy produce, raw wool and timber, and exporting manufactured goods and coal; to deal with similar trade the sister port of Immingham has been more recently constructed a few miles farther up the sheltered estuary at a point reached by a deep-water channel.

The Lincoln Wolds.—The chalk sheet rises from beneath the coastal marshes and boulder-clay cover to form a low plateau; in the south and centre its south-westward-facing escarpment reaches about 500 feet, but in the north, though it is more regular in outline, it becomes lower till it is cut short by the Humber estuary.

Soils, surface-forms, vegetation, type of farming and distribution of settlements are rather like those of the East Anglian downlands, for boulder clay and some glacial sands lie above much of the chalk. A thin loam soil has developed on the remaining areas, and the generally large farms, supporting but a scanty population, are occupied with sheep-rearing and the

associated growing of barley, wheat and root-crops, together with the maintenance of pastures.

The Lincoln Clay Vale.—From beneath the chalk escarpment clays outcrop, together with some Lower Greensand, similar to those of the Oxford Clay Plain and the Bedford Lowland, and as in the case of the latter the surface conditions are varied by glacial gravels and boulder clay and adapted to mixed farming.

The vale is drained northward to the Humber and southward by the River Witham to the Wash, and belts of alluvium accompany the lower courses of the rivers at both ends of the region, especially marked in the wide southern end of the vale adjoining the Witham. Along these belts drainage has been necessary and the country has a fen-like character; indeed, the Fenlands region extends from the south far up the clay vale.

The Limestone Belt.—The chalk wolds and the clay vale of Lincolnshire are separated by the depression of the Wash and Fenlands from the analogous regions to the south, but there is no such break in the continuity of the limestone belt. In Lincolnshire, however, it becomes narrower and lower than it is farther to the south, and its direction is almost due north and south. There is a marked and regular escarpment, though this rises to little over 200 feet except in the extreme south of the county. In its northern portion it is known as the Heath and the escarpment as the Lincoln Cliff or Edge. It is a small and relatively unimportant region, but it is marked by a striking gap where the Witham breaks through the ridge.

Like the gaps in the chalk escarpment in Southern England, this breach in the limestone points to a time when the low plateau extended westward beyond its present edge, and like other gateways traversed by a river, it is a nodal point for communications. Here is Lincoln, by its name shown to be a Roman settlement, and later the chief town of the county. As a city with good road and rail facilities, in touch both with rich agricultural regions and also with supplies of coal and steel, it has developed a considerable industry in the making of agricultural machinery and implements.

Iron-ore is obtained from the Middle Lias rocks of the escarpment near Lincoln city and farther south near Grantham, but a greater production comes from the Lower Lias just in front of the Lincoln Edge south of the Humber. Here at Frodingham and Scunthorpe are huge quarries and blast furnaces; the

development has been aided by the thickness of the seams and by the position of the outcrop between the Yorkshire coalfield from which the coal is obtained and the Humber ports from which much of the pig-iron and steel are sent away.

West of the limestone belt, Lincolnshire includes a part of the broad lowland drained by the Witham and the Trent ; this area will be dealt with in the next chapter.

It may be noted that Lincolnshire, like some other large English counties, has been divided for administrative purposes : in the Fenlands portion, there is the suggestively named division, Holland ; the south-western part is Kesteven ; the northern division is Lindsey.

East Yorkshire Regions.—The regional units of Lincolnshire are to some extent continued across the Humber estuary.

Holderness.—The coastal plain of Holderness is somewhat similar to the Lincoln Marsh region. The chalk of the Wolds dips down beneath it and is covered by boulder clay except for areas of river alluvium. (In both regions, therefore, the geological map shows the “solid” chalk to extend farther east than the true chalk country.) Holderness is a region of low, irregular relief, originally marshy but now largely drained and thoroughly cultivated. The “wheat-lands” of England extend from East Anglia into this corner of Yorkshire ; barley and oats are also grown, and root-crops and pasture give food for cattle.

The low cliff coast, formed of loose material offering little resistance to waves and currents, is being rapidly eroded and within historical times many villages have disappeared ; the material thus removed is swept southward, and some of it is deposited at the mouth of the Humber estuary to form the low hook of Spurn Point. Within the estuary itself, also, there is rapid deposition of the tide-borne marine detritus and river alluvium, so that much new land has been, and is still being, built up between Spurn Point and Hull.

On the landward side of Holderness a small river, the Hull, formed a creek, and this, centuries ago, gave shelter and a landing-place which determined the *site* of a small port. Here Kingston-upon-Hull, to give the settlement its full name, grew up, and became important when the growth of the woollen and iron manufactures of Yorkshire gave it a significant *position* on the waterway leading from the new industrial region. With Southampton, it now heads the list of the second-rank ports of

Britain, viz. Hull, Southampton, Manchester, Glasgow and Harwich, but in volume and value of trade it is far behind London and Liverpool. Its exports of woollen goods, iron and steel goods and machinery, and coal are to be expected from its position, and its export of cotton manufactures shows that its "hinterland" extends to Lancashire. The imports include wheat, wool, dairy produce, crude oil, oil-seeds and nuts. The list of imports indicates how its activity as a port has affected its industrial development, for there are great flour-mills at Hull, and it has large works for the crushing of the seeds and nuts, the refining of oil and the making of feed-cakes from the refuse; also factories for the preparation of paints and varnishes. There is also a large import of fish, the quantities landed here being second only to those at Grimsby. With these varied activities, Hull has a population of about a third of a million, and is growing more rapidly than most British conurbations.

The Yorkshire Wolds.—The great sheet of chalk, whose characteristics and form have so important an influence on the geography of Southern and Eastern England, here reaches its northernmost extension. The escarpment which runs almost north-westward near the Humber, turns about 20 miles from the river and swings round eastward; it therefore faces northward, overlooking the Vale of Pickering, and then reaches the coast where the chalk of Flamborough Head projects because it offers more resistance to erosion than the clays on the north and the glacial deposits on the south.

The dip of the chalk is therefore towards Holderness on all sides, and the lower slopes even of the Wolds are covered with boulder clay. The higher areas, however, rise above this thick mantle, and the north-western part of the escarpment reaches over 800 feet. The region naturally resembles the chalk land of the south of England, for the soil is generally thin, light and flinty; the natural vegetation is grass and gorse, and there are beech woods. The land has, however, been enclosed, and there are no open sheep-runs; while the feeding of sheep is one of the objects of the rotation of crops, there is a considerable production of barley and wheat as well as of grasses and fodder crops. As in the southern chalk lands, the population is not great and settlements are small.

The Vale of Pickering.—The clays which, south of the Humber, outcrop from beneath the chalk and form well-marked, low

regions, scarcely appear immediately to the north of that river, but occur again north of the chalk escarpment, in the Vale of Pickering. This hollow is almost completely enclosed, for it has the North York Moors rising opposite the chalk, and on the western side there are lower hills between it and the Vale of York. In pre-glacial times the drainage was eastward between Flamborough Head and Scarborough, but the ice blocked up this opening which is now occupied by a morainic bar. Consequently water accumulated in the Vale and formed a lake whose level rose till it overflowed the low hills of the south-western margin, and the stream thus formed, the present Derwent, cut a well-marked gorge below the present site of the town of Malton.

To this lake the surrounding uplands were drained, and over its bottom was spread alluvium. Although the central area is still liable to flooding, this deposit makes the Vale a productive region especially noted for cattle-rearing. Pickering is a market town on its northern margin.

The North York Moors.—The Jurassic limestone belt suffers a marked change north of the Humber. It scarcely outcrops from beneath the chalk sheet until the chalk escarpment swings eastward; then it forms the low hills which are cut by the Derwent, and farther north the Jurassic rocks rise to form the upland of the North York Moors, but they have here a different composition. They still bear the same geological names, but the so-called "Oolites" are in Yorkshire largely sandstones. Moreover, the beds are of considerable thickness and form a high mass reaching over 1,200 feet in the Hambleton Hills of the west and over 1,400 feet in the Cleveland Hills of the north. The eastern side, which is much lower, forms an irregular cliff-coast with small fishing towns and health resorts, such as Whitby and Scarborough.

The valleys leading eastward to the sea and southward to the Vale of Pickering have farms and villages, but the upland is a barren moorland with great expanses of heather and small areas of bog. As it resembles parts of the Pennines, more than the southern portion of the Jurassic belt, the divisions of the geological map might prove a misleading guide to the nature of the country; it is, indeed, best regarded as an exclave of the uplands of Northern England.

The importance of the area has been much increased by the occurrence of beds of iron-ore in the middle Lias marlstone which

outcrop in some of the valleys and especially on the Cleveland escarpment. The discovery, nearly a century ago, of a method of smelting this ore caused the growth of the iron and steel industry of Middlesbrough, but the northern beds have been largely exhausted, and the remainder are more difficult of access. Consequently, the amount of iron-ore obtained is decreasing and the district is again losing its economic significance.

CHAPTER VIII

THE NORTH-EASTERN LOWLANDS

Trent and Ouse Vales.—The lowlands drained mainly by the Trent below Nottingham and by the Yorkshire Ouse lie between the Jurassic and chalk outcrops on the east and the Pennines on the west.

They are underlain by Lias clays and New Red marls and sands, and on their western margin by a strip of Permian rocks, often shown on geological maps as “Magnesian Limestone.”

From beneath these layers rise up, westward, rocks of the Carboniferous system, which in the southern part of the Pennine margin are Coal Measures and contain valuable seams of coal. Consequently on the south-east border of the Pennines is the York, Derby and Nottingham coalfield, which is here considered as a separate region and as forming part of the western boundary of the Trent and Ouse vales, regions of essentially agricultural character. As the section in Fig. 34 shows, the Coal Measures dip below the later layers of the plain, and since mining by pits sunk through these layers has proved profitable, the coalfield has extended eastward far beyond the outcrop of the Coal Measures and invaded the farm-lands of the plain. All the region from which coal is now obtained will be treated as part of the York, Derby and Nottingham coalfield region.

The Trent and Ouse vales have been worn down on the weakly resistant clays, marls and sands by the two longitudinal, subsequent rivers which seem to have captured most of the consequent streams which have run down the Pennine slopes. The Humber cut its way across the Jurassic and chalk scarp-lands where these are lowest, and so became the “master stream” of the whole system, drew the waters to itself southward by the Ouse and northward by the Trent, and thus gave a certain unity to the long, lowland region.

Along and across the great hollow, the ice from the north deposited broad masses of boulder clay and ridges of gravels

which formed a mantle over part of the sands and clays. Later, these deposits were covered with recent alluvium in the lowest areas ; this has occurred both along the courses of the Trent and Ouse throughout the vales, and also over much of the central part where Trent and Ouse meet to form the Humber.

The Humber-head Levels.—This central, alluvial area forms one of the constituent regions of the long vale, and its characteristics are similar to those of the Fen District. Though it is now drained, it is still liable to flood, for it lies only a few feet above sea-level and the rivers have had to be embanked. Up the Trent, the tide advances in the bore called the “ægir,” and as the tide penetrates all the rivers of this low area, it has been utilized in the reclamation of the marshes by the process known as warping. At high tide the silt-bearing water is allowed over the low land ; it is then impounded so that it must drain slowly away and deposit the silt ; after many repetitions, a layer of fertile soil is thus obtained. The farming and its products, and the way of life in general, in this region resemble those of the Fenlands. West of the lower Trent is an area (marked X on the regional map) still known as the Isle of Axholme, reminding us of the time when it was an island of habitation surrounded by flooded marsh lands, here called “moors.”

The port of Goole may be taken as marking the head of the estuary, for it forms the innermost of the group of Humber ports, with rather less trade than the outermost, Grimsby, but of much the same type. At this place the Aire and Calder canal, which brings much traffic from the West Riding mining and industrial region, joins the river, and here is the lowest point at which a railway crosses the river from north to south.

The Vale of Trent.—The belts of clays, marls and sands, the alluvial flood-plains of the Trent and other streams, and the patches of glacial clay and gravels, give local variations in elevation and soils ; the ensuing characteristics have done much to determine the types of farming and the positions of settlements in the vale, in the same way as explained in connexion with similar regions elsewhere. Cattle-rearing is important, and a marked contrast may be noticed between the method of feeding in this “New Red” plain and that referred to in the preceding chapter on East Anglia. Here the cattle are kept to a considerable extent on the reclaimed alluvial areas or the

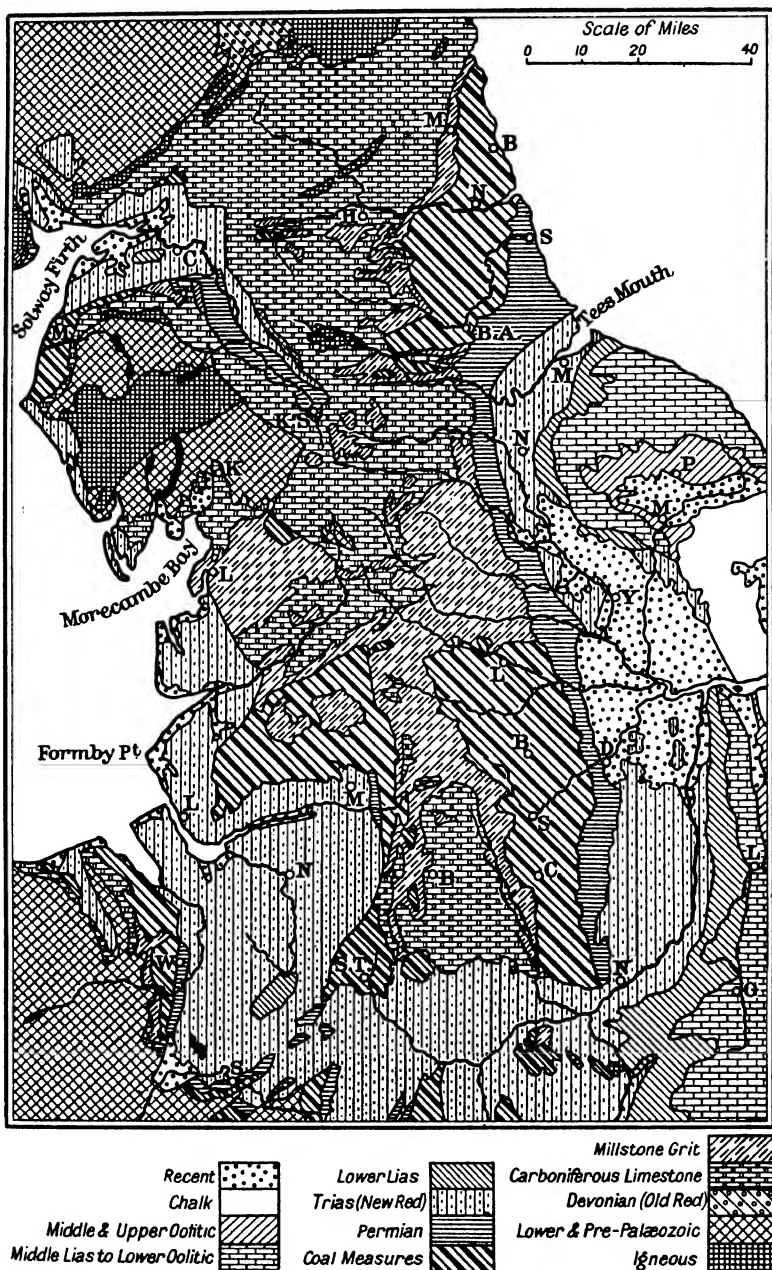


FIG. 32.—GEOLOGY OF NORTHERN ENGLAND.

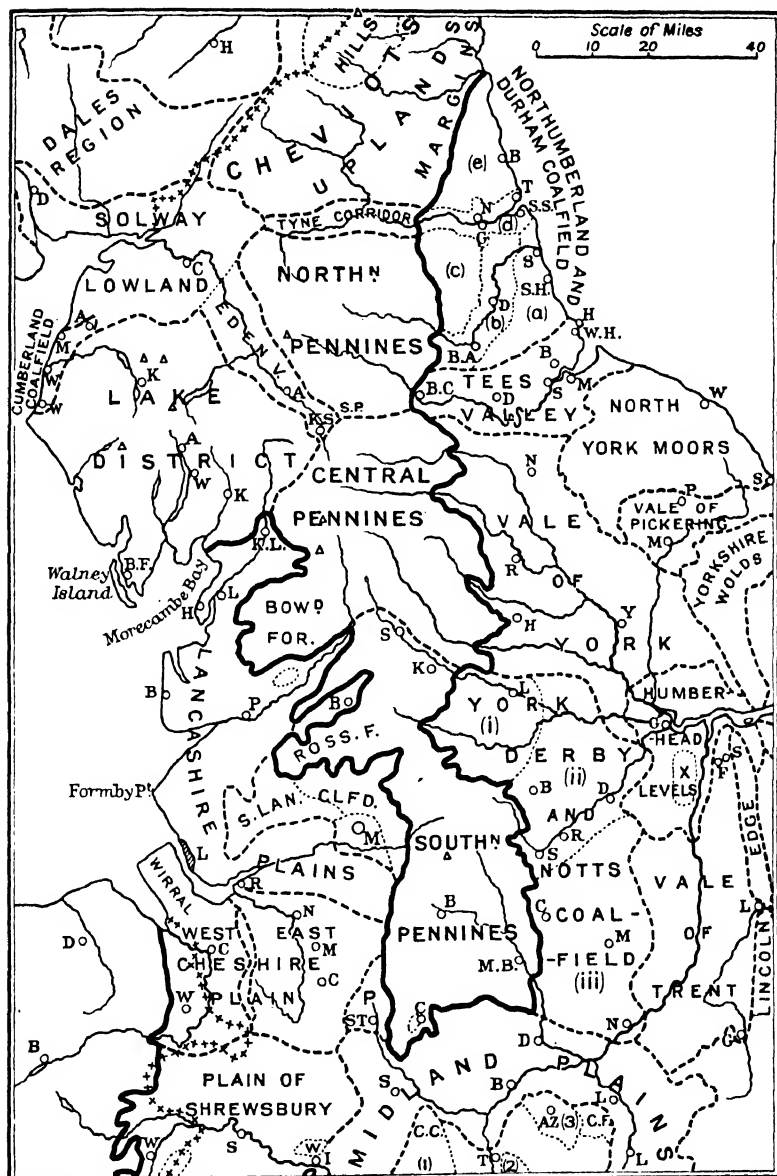


FIG. 33.—REGIONS OF NORTHERN ENGLAND.

damp clay belts, where the ground is utilized as meadow land ; the animals are pasture-fed on the grass during the summer, and sold to the butchers in the latter part of the year. In this vale the market towns are of moderate size, the most important being by the Trent itself.

The Vale of York.—This northern part of the region is similar in many ways to the Vale of Trent, but there are some differences. Firstly, floods used to be extensive, with the result that alluvium covers wide expanses and the settlements arose largely on the higher margins ; where the vale decreases in altitude towards the Humber, its characteristics resemble those of the Humberhead Levels and no definite line can be drawn completely separating the two regions.

Secondly, the ice left a number of morainic masses of which two are of special significance. Where the north-west corner of the North York Moors approaches the Pennines there is a narrowing of the lowland, and across this space a bar of terminal moraine forms the divide between the drainage southward to the Ouse and northward to the Tees ; thus the northern limit of the region is determined by the glacial deposit.

Farther south, in a somewhat similar way, another morainic bar crosses the lowland from the north-western part of the Yorkshire Wolds, past the site of the city of York to the Pennines. It is no accident that York is situated on this line, for the Ouse has cut through the bar at this point, and the site of the city was determined by the intersection of two route-ways : one along the river and the other along the morainic ridge which gave dry passage across the marshy lowlands.

With its site thus provided, York had a position which allowed a considerable growth in earlier centuries, for it was the centre of the agricultural and productive lowland part of Yorkshire and on the main route between England and Scotland. It became a cathedral city and the seat of the second archbishopric of England. With the development of the manufacturing centres of Yorkshire it lost its pre-eminence ; moreover, it is no longer even the administrative centre of the geographical county, for this has been divided for administration into three " Ridings," East, West and North, and the City of York is at the meeting-point of all three.

The narrowest part of the Vale of York is at its northern end, where it is sometimes called the " Northallerton Gate," from the

market town in its centre. As a whole, the vale is a productive farming land. The important wheat-producing lands of England here reach their northern limit, and barley and oats are also grown; cattle are kept in considerable numbers for beef and to a less extent for dairying. Besides York and other settlements along the Ouse, there is a series of market towns on the higher land of the western margin of the plain. Some of these towns are at the entrances to the dales; Ripon is a cathedral town on the Ure, and Harrogate is a spa with mineral springs at the foot of the Pennines.

The York, Derby and Nottingham Coalfield.—Broadly speaking, the southern part of the Pennine Upland is an upfold of Carboniferous rocks from the crest of which the Coal Measures have been worn away, leaving their outcrops on either flank,

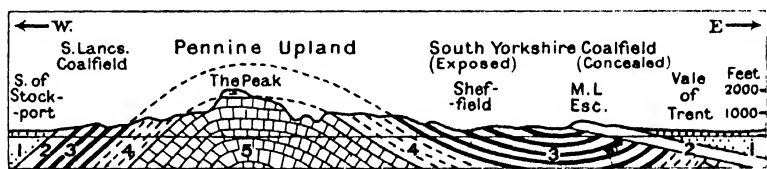


FIG. 34.—SECTION THROUGH THE SOUTH PENNINE UPLAND AND COALFIELDS.

- | | |
|------------------------------------|------------------------------|
| 1 = New Red Layers. | 4 = Millstone Grit. |
| 2 = Permian (Magnesian) Limestone. | 5 = Carboniferous Limestone. |
| 3 = Coal Measures. | |

while farther north, in the central Pennine area, the Coal Measures have been entirely denuded. Consequently there is a coalfield which stretches along the south-east margin of the Upland in the counties of Derby and Nottingham and through the West Riding of Yorkshire as far north as the valley of the Aire. This is the most extensive and the most productive of the British coalfields, and with its "concealed" portion beneath the adjoining plain it has the greatest reserves. There are thick seams of valuable coal, which outcrop with little interruption for long distances from north to south and which continue fairly regularly to the east; these characters make for simple and profitable working and have led to widespread mining.

This was at first limited to the neighbourhood of the outcrops on the western side of the field, and the valleys cut by the rivers gave easy access to the seams, but as these areas were exhausted

deeper pits were sunk to reach the coal farther east ; consequently there has been, as it were, a slow eastward displacement of the actual mining area, till it now extends almost as far outside the limit of the Coal Measures as shown on the geological map as within it. This is especially the case north and east of Doncaster, itself well beyond the surface outcrops, and again in the southern area to the east of Mansfield. The eastern limit of present mining is shown by the eastern boundary of the coalfield in the map of regional divisions.

The coalfield, past and present, with the industrial developments arising from it, therefore overlaps the Pennine margin, extending westward up the valleys and eastward into the lowland. Hence arises the question whether the coalfield should be treated as a regional entity. On the whole, it seems desirable to do so, for there is an underlying unity of structure, and the region shows characteristics common to coalfields in general, the economic conditions having great importance. Moreover, the mining and industrialized valleys of the coalfield region may be regarded as lowland areas eroded from the Pennine margin, for the 600-foot contour line may be taken as approximately the westward boundary of the region ; the only exceptions are isolated settlements in the narrow upper portions of the valleys of the Aire, Calder and other rivers which have cut their headstreams very deeply into the Pennines.¹

The economic conditions within the tract, however, are by no means uniform. As on other coalfields, industrial developments have taken different forms in different parts, and there are also large areas which have retained their generally rural appearance ; small villages adjoining pit-heads with dumps and railway sidings are sometimes the main indication that there is mining for coal which is exported from the district.

The Southern Area.—This area, marked (iii) on the regional map, is mainly in the counties of Derbyshire and Nottinghamshire. The south-east corner of the coalfield is marked by the large town of Nottingham, which arose by a fairly easy crossing-place of the Trent. Its development has been varied ; as in the Black Country, an earlier iron and steel industry based on ore

¹ Coalfields which have a similar structure on the margins of uplands, and therefore show similar extensions from lowlands into the adjacent valleys, are found in other parts ; e.g. in Lancashire across the Pennines, and in the Ruhr region of Germany. In these cases, too, the human geography demands a unity in the treatment of the coalfield.

and local charcoal as fuel has given place to the making of motor-cars, cycles, etc. ; early textile industries have resulted in a large manufacture of lace, hosiery and " knit-wear " in general, and the making of textile machinery ; the gypsum of the New Red plain has aided the brewing of beer ; the cattle-hides from the same area were a factor in the growth of tanning and leather-working. Nottingham now has more than a third of a million inhabitants, and is still increasing in size.

The southern part of the great coalfield, that situated west and north of Nottingham, has good household coal, and from it much of the supplies of metropolitan England are obtained. The coal is also used in the region itself at several centres in forges and foundries, for the production of heavy iron and steel goods. Chesterfield is the largest town, with some textile work in addition to a considerable amount of engineering. In general, however, this part of the region has preserved landscapes of rural aspect varying according to the nature of the underlying rock : there are stream-eroded shales in the Coal Measures area of the Pennine margin, a low limestone escarpment in the band of Permian strata adjoining this on the east, and sands and marls in the plains.

In the eastern part of the coalfield in Nottinghamshire the mining developments have social significance. The areas near Mansfield, known as Sherwood Forest and " the Dukeries," have in late years been invaded by pits reaching the concealed coal-seams, and new villages have been built around them. Unlike the ill-built and insanitary hovels of the earlier days of mining, the houses here are equipped with such conveniences as baths and electric light, and with the higher wages paid in the recently developed mines as compared with those of the older and now less profitable areas, labour was immediately attracted to this district.

Because of the differences within it, this southern part of the coalfield, like the two more northerly areas, would have to be regarded as a stow group for purposes of more detailed study.

The Central Area.—The central portion of the York, Derby and Nottingham coalfield, marked (ii) on the regional map, is mainly situated in South Yorkshire, in the basin of the Don, and extends into that of the Aire below Leeds.¹ Centuries ago

¹ The central and northern parts of the coalfield are shown more clearly on the geological and regional maps drawn on a larger scale in Figs. 36 and 37.

an iron industry arose in the valleys of the Don and its tributaries on the Pennine margin, using the iron-ore of the Coal Measures, charcoal as fuel and the water of the swift-flowing streams for power. A special direction was given to its development, namely that of making cutlery, by facilities for obtaining grindstones from the "Millstone grit" which underlies the Coal Measures and forms the edge of the Pennine Uplands adjoining this area. A most convenient centre existed where the Don was joined by several tributaries including the Sheaf; here Sheffield grew up, and it has retained its long-famous industry of cutlery and plate, though iron and steel now have to be brought from Cleveland and Cumberland, and even from Spain and Sweden. Numerous other branches of the steel industry have developed, e.g. the making of machinery of many kinds, and offensive and defensive armaments. There is now a tendency to specialize in the finest work, in which the lack of raw material is not a serious handicap, while a great advantage lies in the possession of a skilled labour-market and the "good-will" of old-established firms. Aided by research in the metallurgical laboratories of the University of Sheffield, the use of alloys of steel and other metals which have new and valuable properties is a special characteristic of the work.

Based on these industries, Sheffield has a population of over half a million, but its rather remote situation is a drawback to development, and it is the only one of the great conurbations which showed no numerical increase in the decade preceding the census return of 1981. The city is, as it were, pent in at the convergence of the small valleys, and from the residential suburbs of the surrounding hillsides it often appears almost hidden beneath a pall of smoke.

The industrial district has tended to move down the valley, and buildings accompany the course of the Don to where, at its junction with the Rother, the town of Rotherham is situated. Here there are great works similar to those of Sheffield, and the iron and steel industry has still another centre farther down the river at Doncaster. This town is situated where a Roman road crossed the river; it is beyond the outcrop of the Coal Measures, but the seams are at no great depth, and the canalized river gives good water communication with the Humber ports. Doncaster has construction and repair shops for the London and North Eastern Railway.

North of the industrialized Don valley there is another area where coal-mining for export is the main development ; Barnsley is the chief centre of this district.

The West Yorkshire Area.—This region, marked (i), includes the middle part of the valley of the Aire, and most of the lower part of the valley of its tributary, the Calder. These valleys have for centuries been famed for their manufacture of woollen goods, aided in early days by the streams which provided not only power but also abundant soft water from the Millstone-grit area of the Pennine Uplands behind, by supplies of wool from the upland and lowland pastures on either side, and later by the coal and iron-ore of the Coal Measures. These factors have varied considerably in their importance from age to age : water-power gave place to coal, and now the coal-mining area is mainly in the plains below Leeds and Dewsbury ; not much iron-ore is obtained, and by far the greater amount of the wool is imported from overseas. The relative importance of the various centres within the region has also changed, and so have their special activities.

In Leeds, once the chief seat of the woollen manufacture, this work is now of quite secondary importance ; the city is at the centre of routes skirting the uplands, penetrating the valley of the Aire on which it stands, and crossing the watershed to the valley of the Calder a few miles to the south.

Moreover, it should be noticed that the Pennine barrier between north-eastern and north-western England here narrows, and that the Aire and Calder valleys have relatively low water-partings from those of the Lancashire slope ; consequently there are now road, railway and canal communications through these valleys. Leeds is therefore in an almost central position in Northern England, and it has grown into a great trading community, with a University and other indications of its regional importance. Its woollen industry has to a large extent been replaced by the manufacture of clothing, largely from materials produced in other towns of the region ; this work is indeed now second to engineering, including the making of machinery for the woollen and other textile industries, and the construction of locomotives and engines for motor-cars and aeroplanes.

The chief seat of the manufacture of wool is Bradford, situated in a side valley higher up the course of the Aire. Here, however, most of the work is concerned with the spinning and weaving of

worsted goods, made from the longer fibres, rather than of the *woollen* goods from shorter fibres; taken as a whole Yorkshire's pre-eminence is in worsted goods, while woollen goods are produced also in the West of England, in Lancashire and in the Tweed valley. Bradford is, further, much concerned with the buying of raw wool, and with the dyeing, finishing and sale of the woven materials.

In the Calder valley, Dewsbury is well known for its making of shoddy goods, and on side-streams entering the Calder are Huddersfield, famous for "tweeds" and high-quality cloths, and Halifax, where carpets as well as other woollen goods are produced. At Bradford and Huddersfield much textile machinery is made.

There are numerous other manufacturing centres in the Aire and Calder valleys and on the watershed between them, and there is indeed a continuous conurbation including all the towns mentioned. Of these, the city of Leeds is by far the largest, with about half a million inhabitants, the city of Bradford follows with almost a third of a million, and the whole conurbation has a population of about $1\frac{1}{2}$ millions. Its growth is still continuing, though more slowly than in the past.

Rather apart from other woollen manufacturing towns, Wakefield is in the lower part of the Calder valley; the work of the city includes the making of machinery, and it is a coal-mining centre.

The North-east Coast Regions.—At the north-eastern corner of the Pennines, in South Durham, there is the same sequence of rocks as already noted at the south-eastern corner in Nottinghamshire and Derbyshire, though in the north-east coast area the dip of the rocks is not due east, but rather east-south-east.

Consequently, there is a lowland of New Red marls and sands in the lower Tees valley; from below these there rises to the west and north-west a belt of Permian (Magnesian) limestone which has a westward-facing escarpment (see the geological section in Fig. 35); this edge overlooks the outcrop of the Coal Measures of the Northumberland and Durham coalfield, which is in turn bordered westward by the Millstone grit and the Carboniferous limestone of the Northern Pennines.

Owing to the subsidence of the North Sea area, these belts are cut obliquely by the coast, and the same succession of rocks is

found forming the coastal regions: New Red sands and marls around the estuary of the Tees; Permian limestone to just beyond the mouth of the Wear; Coal Measures across the Tyne estuary to the Coquet mouth; the lower Carboniferous rocks to the mouth of the Tweed.

The coast is, with the exception of the two above-named estuaries, almost straight. This is due partly to the action of the sea and partly to the cover of glacial material which has filled in previously existing hollows; boulder clay covers a considerable part of the surface of the lower lands of this area.

The region as far north as the Coquet mouth comprises two tracts: (1) the whole of the valley of the Tees below Barnard Castle; (2) the Northumberland and Durham coalfield, consisting of two main portions, in the north-west the exposed area of

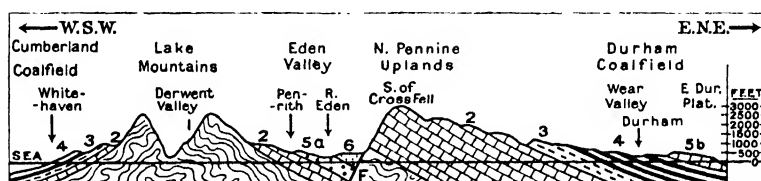


FIG. 35.—SECTION THROUGH THE LAKE DISTRICT AND THE NORTHERN PENNINES.

- 1 = Lower Paleozoic Rocks.
- 2 = Carboniferous Limestone.
- 3 = Millstone Grit.
- 4 = Coal Measures.

- 5a = Permian Marls and Sands.
- 5b = Permian (Magnesian) Limestone.
- 6 = New Red Layers.

the Coal Measures which begin near the Wear valley by Bishop Auckland, and in the south-east the "concealed" coalfield below the Permian limestone east of the Lower Wear valley.

The Tees Valley.—Below Barnard Castle this valley has been eroded from a succession of strata, viz. the lower Carboniferous rocks, the Permian limestone and the New Red sands and marls, but no marked relief is found to correspond with the changes in the subsoil, while over a large area there are glacial deposits to mask other differences. The valley gradually becomes lower, river-meanders develop below Darlington, and from Stockton-on-Tees to the coast the land near the river and its estuary is occupied by a conurbation of a commercial and industrial character.

Over most of the valley agriculture is the chief work; as

regards soil conditions there is much resemblance to the northern part of the Vale of York, from which it is separated only by the bar of morainic origin, and consequently the farming is of a similar type. Some wheat and barley are grown for sale, but fodder crops and pasture occupy much of the land as the main aim is the keeping of cattle, both for fattening and for obtaining dairy produce demanded by the industrial towns.

Darlington and Stockton were, and are, the market centres of the valley, but a development was marked when, a little over 100 years ago, they were joined by the first public railway in England. This was constructed to carry coal from the near-by coalfield to the navigable lower Tees for export. At Darlington there are building works of the London and North Eastern Railway, for the main "East Coast route" to Scotland crosses the Tees at this point. From Stockton down-stream on either side of the estuary extends the conurbation sometimes called Teesmouth. On the Yorkshire side is Middlesbrough, whose trade and industries are closely connected with iron and steel. Its rapid rise followed the utilization of the Cleveland ore, for it was then between the neighbouring sources of coal, iron and limestone, and could easily send away the products by sea. Here at Teesmouth, for a time, flourished the greatest iron and steel industry of Britain, but two changes have occurred; the supply of local ore has diminished and now has to be imported from the more southern part of the Jurassic belt and from abroad, and also increasing competition has developed in other parts of Britain and in other countries, and in consequence the production in this district has experienced a setback.

A decline has also occurred in the industry which here was the most important derivative of the iron and steel production, viz. shipbuilding. With the advantage of the chief materials for this work being obtained where deep water facilitated launching, the shipyards of the Tees and the neighbouring Wear and Tyne estuaries carried on half of the whole British shipbuilding at the beginning of the present century. But, as in the iron and steel industry in general, this "North-east Coast" area lost its pre-eminence in the supply of ships for the British mercantile marine. Further, since the War other nations have taken a greater share in the carrying trade of the world, and the total requirements of the British shipowners have greatly decreased. There has therefore resulted a heavy fall in the work carried on

by the three estuaries, and also at Hartlepool and West Hartlepool a few miles north of the Tees.

Another branch of the steel industry at Teesmouth is the production of "structural steel" for buildings, bridges, etc., and with the increasing use of steel for these purposes this branch has not suffered in the same way as shipbuilding.

A growing activity in the same district is the production of various chemicals, which likewise have found increasing use in manufacturing, as well as in agriculture for manures. The chemical industry has been specially aided by the occurrence of salt and gypsum in the New Red strata which underlie the Tees estuary. At Billingham, north-east of Stockton, a very large plant has been constructed, and a recent development, which may become more important, is the production of petrol from coal.

The total population of the Teesmouth conurbation is about a third of a million, and in spite of the decline in shipbuilding and some other branches of the iron and steel industry, it showed a considerable increase during the last census decade.

The Northumberland and Durham Coalfield.—From the point of view of the amount of coal produced, this field ranks with that of South Wales, both coming some way behind the York, Derby and Nottingham field, but far exceeding any others in the British Isles. It is convenient to treat the whole of the area from which coal is obtained as a unit, but this tract has five well-marked stows: (a) the East Durham plateau of Permian limestone; (b) north-west of the limestone escarpment, the Vale of Durham drained mainly by the middle Wear; (c) west of this hollow, the North Pennine margin; (d) north of these regions, the lower Tyne valley with its numerous large settlements; (e) the southern part of the coastal plain of Northumberland.

The East Durham Plateau.—The thick sheet of Permian limestone, with some sandstones interbedded, which overlies the Coal Measures is the factor which distinguishes this region from its neighbours. It forms a plateau overlooking the Vale of Durham by an escarpment over 400 feet in height and dipping eastward towards the coast of low cliffs. On it there is a thinner layer of boulder clay than on the lower areas, and because of the permeable rock there is less surface water. Crops are mainly of fodder for cattle-rearing, which aims at

producing stock to be fattened in more productive country and gives less attention to dairy farming.

An important resource of the region is the mining of coal, and as the pits have to be driven deep they are relatively few, each giving access to a wide area of the seams beneath ; consequently the pits are used by relatively large colonies of miners who live in small towns which have grown up near the pit-heads. Much of the coal is of a kind used for obtaining gas and for domestic purposes, and is exported largely from Sunderland and Seaham Harbour. Sunderland is situated at the mouth of the Wear, which cuts through the northern tip of the plateau ; besides exporting coal, it imports timber for pit-props, and has had a large share of the shipbuilding whose fortunes have been referred to in preceding paragraphs.

The Vale of Durham.—This lowland, worn by the Wear from the shales and other rocks of the Coal Measures and covered by much glacial material, has a wetter soil than the limestone plateau, and its farming results in rather more crop production and the raising of more cattle. The mining has been carried on with shallow workings and for a long period, and consequently many of the seams have been exhausted. The region has an additional characteristic in that it is part of the important East Coast route upon which Durham has grown up. The city has a long history ; on a site almost surrounded by a deeply cut meander of the Wear, a castle, a cathedral and a University have been built, and the city still functions as a market town and an administrative centre.

The North Pennine Margin.—From several points of view this is the poorest of the areas of the coalfield. The region consists of the lower upland slopes dissected by valleys, and the higher areas are merely moorlands which should, perhaps, be included in the Pennine region. The lower portions provide poor farming country, and the main resource of the region is its mining. Originally this was encouraged by the outcrop of the seams in the valleys, and surface quarrying and shallow workings led to the rise of numerous small mining villages, ill-built and often insanitary. The area was, moreover, rather isolated in its situation, and the coal was sent away for use elsewhere, much of it providing coking-coal for the furnaces of the Tees and Tyne iron industries. No other resources gave a broader base to the economic life of the region, and with the exhaustion of the early

worked seams the mining has declined. This decline has been accentuated by the difficult post-war conditions of the British coal industry in general, for in recent years other nations have tended to produce as much as possible for themselves where previously they purchased British products ; further, the widespread utilization of water-power and oil has tended to restrict the demand for coal. For these reasons, this Durham field has suffered severely, many of the mining villages becoming centres of poverty and destitution.

Tyneside.—The lower Tyne valley is one of the greater conurbations of Britain. Based mainly on the coal of the hinterland, there has grown up a series of settlements from Newcastle-upon-Tyne, faced across the river by Gateshead, past Wallsend and Jarrow, to North Shields and Tynemouth on the Northumberland side and South Shields on the Durham side of the estuary.

Down-stream from a little above Newcastle, the river has a narrow flood-plain bounded by high banks, and the site of the city is a close parallel to that of London, for it is at the lowest bridge-place where on the northern bank was a defensible landing-place. It had an importance for centuries because of its position on the East Coast route, at a point where this was reached by navigable waters on the east, while on the west the upper part of the Tyne valley gave an easy road across the Pennines.

The great growth of Newcastle, as of the other centres in the Tyneside area, was based on the opening up of the coalfield. It has an export of coal and coke and of iron and steel goods, while its import is mainly of timber, iron and other ores, together with provisions for the mining and industrial population of the north-east coast.

The shipbuilding of Tyneside, carried on at several centres, has already been referred to, and allied branches of engineering, such as the construction of marine engines, have shared its importance. The iron and steel industry has developed also on other lines, producing, for example, railway engines and other means of transport. Aided originally by obtaining lead-ore from the Northern Pennines, a lead-working industry grew up, and chemical works were also established.

The lessened demand for British goods abroad has affected the varied economic activities of Tynemouth in different

measure ; the export of coal and the building of ships have markedly suffered. In consequence, while the main centre, Newcastle, has increased slightly during the last census decade, the settlements on the south side of the Tyne have decreased, and the population of about one million in the conurbation as a whole has remained almost stationary.

The Northumberland Coalfield Area.—North of the Tyne valley the mining has not led to industrial development. There is much “steam-coal,” and this is either sent to the Tyneside centres or exported directly from the small port of Blyth. A feature of this part of the coalfield is that from the bottom of the pits the seams are worked along their dip beneath the sea, even to a distance of 3 or 4 miles from the coast.

Since the demand for steam-coal for shipping has been greatly diminished by the use of oil, this part of the field has greatly suffered. The older mines have now been abandoned, particularly those of the western part, and in the main the area is farming country, resembling that of the Northumberland coast nearer the Border. It may be regarded as the last portion of the English Lowland, and as marking a transition to the Cheviot region, which will be described in a later chapter.

CHAPTER IX

THE NORTH-WESTERN LOWLANDS

THE regions on the western flanks of the Pennines somewhat resemble those on the east, for there are coalfields which have given rise to industrial districts, while in Cheshire and Lancashire as in Nottingham and Yorkshire there are agricultural areas on the outcrops of the New Red sands and marls, and by the coasts are ports which link the industrial districts to distant lands.

Yet there are differences between the eastern and western regions, due mainly to two causes. In the first place, on the western side there have been greater disturbances in the history of the earth's surface; the geological structure is therefore more complicated and the distribution of the mining and industrial areas is less simple. In the second place, the western regions face the Atlantic; the results are that the climate is wetter and more equable, a difference affecting both industry and agriculture, while there is easier access to transatlantic lands than in the case of the eastern regions facing the North Sea.

We will first consider the coalfields and industrial areas on the western side of the Southern Pennines.

The Potteries.—As a counterpart to the Coal Measures of Derby and Nottingham, those of North Staffordshire lie on the Pennine flanks at the south-western corner of the upland, forming a roughly triangular area, and dipping beneath the New Red marls and sands of Staffordshire and Cheshire. The North Staffordshire coalfield ranks among the small ones of Britain, and its industrial development is mainly associated with the making of pottery of many kinds and especially fine china-ware. The early stages of this work were much helped by the fact that in these Coal Measures there are beds of marls and clays from which coarse earthenware goods were made, and potteries were established in a belt along the junction of coal-bearing and clay-providing strata. This belt has as its centre Stoke-upon-Trent, and extends south-eastward to include Longton and

northward to include Hanley, Burslem and Tunstall ; these are the well-known "Five Towns" of the Potteries region, and together with the smaller Fenton are now united in the borough of Stoke-upon-Trent.

Local clays are nowadays used only for the large saggars in which other pots are fired, and the materials for the china-ware are brought from considerable distances. The Trent and Mersey canal was constructed to give a navigable water-way to this region which is situated on the divide between the river systems, and it is particularly useful in affording cheap transport for the heavy and bulky china-clay brought *via* the Mersey from Cornwall. Other materials come from other parts of England, and flints are imported even from Normandy and feldspar from Norway. Besides the coal-mining, the pottery industry and the associated manufacture of glazes, chemicals, paints, etc., the region carries on smelting of black-band iron-ores from the Coal Measures and the making of machinery, including that for the other industries of the district. A few miles to the east is the minor coal-basin of Cheadle, whence but little coal is now obtained.

The whole conurbation of the Potteries, including Newcastle-under-Lyme, a residential borough west of Stoke-upon-Trent, has a population of about a third of a million people, and has shown a considerable increase during the last census decade.

The Lancashire Coalfields.—The Lancashire coalfields differ considerably from their counterpart in Yorkshire, because of the great dislocations which the Carboniferous rocks have here suffered. North of the Potteries, the Coal Measures have subsided to great depths and have been completely covered by the New Red marls and sands, so that there is a break between their outcrop in North Staffordshire and their reappearance in North-east Cheshire and South Lancashire. As shown on the geological map in Fig. 36, the Lancashire coalfields have a roughly triangular outline, with Manchester, St. Helens and Burnley near the three corners, and a "tail" extending southward in Cheshire from near Manchester to Macclesfield. But the whole of this area is not occupied by the Coal Measures, for in the centre of the Lancashire portion the Millstone grit forms two large patches. This central area is a moorland called Rossendale Forest or Rossendale Fells ; its occurrence is due to an up-folding of the strata (known as the Rossendale anticline) to

great elevations, and the subsequent wearing away of the Coal Measures from the highest parts.

Consequently, the mining area has two main divisions: (1) north of Rossendale Forest is the relatively small Burnley coalfield, occupying a valley draining to the Ribble and extending from Burnley past Accrington to near Blackburn; (2) in the south is a much larger area curving round from near St. Helens, past Wigan, Bolton and Bury, and then south of Rochdale past Oldham, Ashton-under-Lyne and its twin town Stalybridge, to near Stockport. Very little coal is now obtained from the "tail" of outcrop of Coal Measures south of Stockport in Cheshire.

Unlike the Yorkshire coalfield, that of South Lancashire does not extend far beneath the New Red layers, because the steepness of the dip and numerous faults, some with a down-throw of thousands of feet, have taken the coal to unworkable depths. The mining and manufacturing region is therefore more closely limited to the outcrops of the Coal Measures.

The effect of the west-facing situation of the Lancashire industrial areas is clearly traceable in the climatic conditions. As the winds come more frequently from a westerly direction than from any other, maritime influence is great and expressed both in higher temperatures during the winter than those experienced on the eastward side of the Pennines, and also in a normally heavier rainfall accompanied by a greater humidity of the air. Although the lowland of Cheshire, situated in the lee or "rain-shadow" of the Welsh Uplands, has an annual precipitation of less than 30 inches, the plains of Lancashire have between 30 and 40 inches, and parts of the Rossendale Fells and of the western slopes of the Pennines have over 50 inches.

The Cotton Region of South-east Lancashire.—These climatic conditions affect the manufacturing upon the coalfields, for in the cotton industry which is concentrated upon the South Lancashire coalfields to an extraordinary degree, the spinning is aided by the humidity of the air. This factor, however, is only one of those which at various times have made possible the development of the industry.

The first "cottons" produced at Manchester and Bolton were really made of wool, and after American cotton was utilized for textiles and the industry required great quantities of this raw material, the position of the region enabled it to be imported

through Liverpool. But short though the distance is between Manchester and Liverpool (86 miles), the early roads were bad and their building and maintenance was made specially difficult by the wet and often marshy character of the surface of the New Red plain ; directly west of Manchester communication was entirely barred by the great Chat Moss.

The Mersey and its tributary the Irwell, on which Manchester stands, were early canalized, and canals were later constructed from the Mersey across the Pennines through the manufacturing

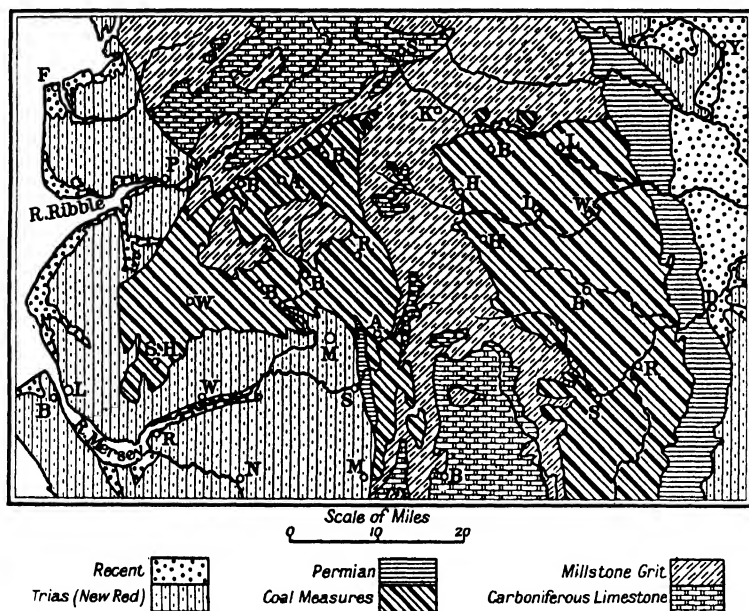


FIG. 36.—GEOLOGY OF THE LANCASHIRE AND YORKSHIRE COALFIELDS.

regions on both sides of Rossendale Forest. On the north the Leeds and Liverpool canal utilized the Blackburn-Burnley valley in the Ribble basin and crossed the water-parting to the Aire valley, while on the south two canals, passing respectively through Ashton-under-Lyne and Rochdale, joined the Irwell to the Calder ; these means of through communication benefited both the cotton industry of Lancashire and the woollen industry of Yorkshire. Railways utilized the same valleys, and a direct line westward from Manchester to Liverpool even crossed Chat Moss.

Still another and very important connexion between the Mersey estuary and the great centre of the cotton trade was afforded by the construction of the Manchester Ship Canal. This canal adjoins the Mersey estuary on the Cheshire side and leaves it at Runcorn; it allows ocean-going ships to reach the docks constructed on the western side of Manchester.

The streams of the cotton-manufacturing region have been a most important factor in the growth of the industry. The heavy rainfall on the Pennines provides an ample supply for the

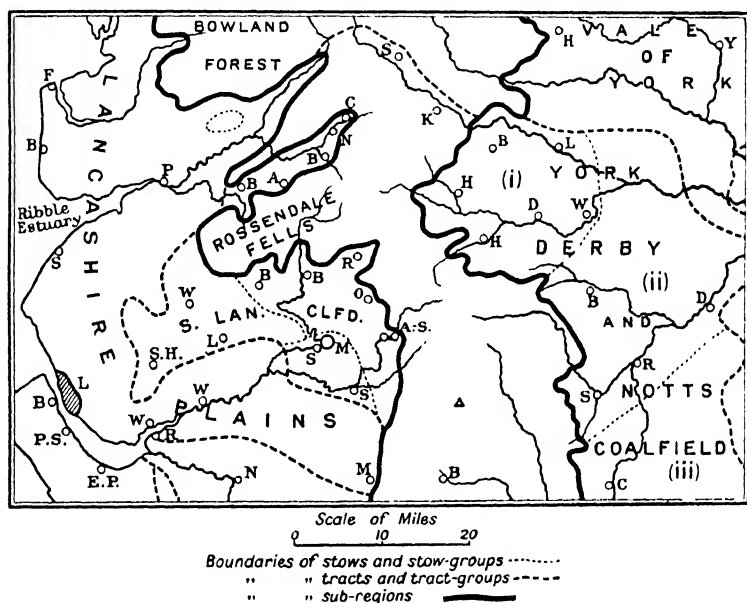


FIG. 37.—REGIONS OF THE LANCASHIRE AND YORKSHIRE COALFIELDS.

very large demands of the industry at several stages of the manufacture; the water is soft because it comes from the Millstone grit; the regularity and reliability of the flow of the streams is aided by the retention of the water in the peat-bogs which cover considerable areas of the Millstone grit moorlands. Another great advantage of the streams was their rapid flow which gave water-power, particularly where they left the uplands to enter the plain, and consequently before the use of coal the mills were set up in the river valleys.

From the amphitheatre of upland which overlooks the Man-

chester lowland on the north and the east, several large streams descend and converge to the Irwell and Mersey, and by the sides of these the cotton industry grew up, with Manchester as its focal point.

With the coming of steam-power, the South Lancashire coal-field gave a further impetus to the development, and a half-circle of large towns now extends along the margin of the amphitheatre from Bolton to Bury and Rochdale on the north, and on the east Oldham and Ashton-Stalybridge, to near Stockport.

The region in which the actual manufacturing of cotton predominates, including these towns, and shown on the regional map to the north and east of Manchester, is situated on the coal-field, and is bounded on the upland side by the 600-feet contour-line. On the lower side it merges into the more commercial region of Manchester, Salford, Stockport and smaller centres; this is shown as a separate area. It lies beyond the main coal-mining area, and in it the trade in cotton has tended to overshadow or replace the manufacturing, while other branches of economic activity have also developed.

There are thus two main regions in South-east Lancashire concerned with the cotton industry, and within these districts certain places have tended to specialize in particular branches and have developed different characteristics. (1) In the half-circle of the Pennine margin north and east of Manchester the spinning and carding is mainly carried on, the greatest number of operatives being employed in Oldham, Rochdale and Bolton; Ashton-under-Lyne and Stalybridge are smaller centres of similar type. In the same area weaving also is done, and in and near Bury this branch has grown to a larger extent than the spinning. The final stages in the preparation of cotton fabrics, such as dyeing, bleaching and calico printing, have a special advantage in ample supplies of soft water, and are mainly carried on where the streams emerge from the grit uplands on to the lowland; many such works are situated near Bolton, below Bury and at Rochdale. Rochdale has a usually wide range of work, for together with its cotton-spinning and some weaving it has retained from the early days of the textile industry the manufacture of wool; its position is significant in this connexion, as it is in the north-east corner of the cotton area and, being on the canal and railway route to the Calder valley, it is in easy touch

with the Yorkshire industry. As in the case of others of the textile towns, Rochdale has also some engineering works, particularly those connected with the cotton industry; in Oldham and Bolton the engineering activities have developed to considerable importance.

(2) The focal area, situated within the half-circle and including Manchester, has an even greater variety in its economic activities. In Stockport, besides a certain amount of cotton-spinning and engineering, leather manufactures and the preparation of a number of food materials are carried on.

In the parts of Manchester adjoining the industrial half-circle there is still a good deal of cotton-spinning, and clothing is made, especially from cotton fabrics. Moreover, on this side Manchester extends into the coal-mining area, but the central part of the city is the commercial "capital" of the whole region, with great warehouses, packing houses and offices of all kinds. The western part of the settlement forms a separate administrative borough, Salford; here there are a number of dyeing and bleaching works, and in both boroughs is a wide range of activities, of which engineering comprises a very important group.

The large canal docks of the port of Manchester have been cut out of low and previously unutilized land in the Salford area, and around them factories have been built to take advantage of relatively cheap communication with overseas sources of raw materials, while petroleum is refined and stored farther down the course of the canal. About a third of the total amount of cotton imported is carried by the canal to Manchester, but about two-thirds is still landed at Liverpool and conveyed by rail, road and the other waterways to the spinning centres. As stated in a previous chapter, Manchester comes into the second group of British ports if judged by the total value of the trade.

In the many professions associated with its multifarious economic life, Manchester has an important position; it is the seat of a University, and around the city a number of large residential districts have grown up, particularly in the agricultural area to the south-west of the city. For the needs of its great population, Manchester had to obtain a water supply from Thirlmere in the Lake District, since the neighbouring Pennine resources had to meet the needs of the industrial towns on both flanks of these uplands. Even this supply has proved inadequate, and a recent development is to raise the level of

Haweswater to secure from this lake large reserves for the people of Manchester and the surrounding industrial districts.

Manchester and Salford together have about one million inhabitants, and there is a total population of well over two millions in the whole conurbation, including both the more commercial focal area and the more purely industrial half-circle of the Pennine margin. Numerically this conurbation is second in Britain only to London, but its growth has practically ceased. The districts which showed an increase in the last census decade were, in the main, the residential suburbs south-west of Manchester, but the commercial centres changed little, while the manufacturing areas generally showed a decline. The cotton industry of Britain has in recent years suffered greatly from the growth of manufacturing in other countries, particularly in Japan and the other parts of the Monsoon Lands, which were once the almost undisputed market of Lancashire.

The rapid growth of the industry in the nineteenth century was accompanied by the building of factories and houses huddled together in smoky and grimy agglomerations; beautiful natural landscapes were converted into deplorable "human landscapes." During the present century attempts have been made to improve conditions, but the decline in prosperity has handicapped reform, and, taken as a whole, this region is one in which the Industrial Revolution produced a state of affairs which it may be hoped will be avoided by the more systematic town-planning accompanying modern industrial developments.

A noteworthy feature of the cotton industry is the extent to which women's labour is required. In the spinning branch of the trade about two and a half times as many women as men are employed, and in the weaving branch the number of women is often six times that of men. This would give a surplus of men's labour, and consequently there is an economic advantage in the co-existence in the same areas of heavy engineering and mining which require almost exclusively male workers. As indicated in preceding chapters, these industries have also suffered a decline in recent years, and this has intensified the difficulties of south-east Lancashire. In this region, however, the coal has not been sent away to any large extent, and the lowered production has been due mainly to the decreased local demands of the cotton and allied industries.

In addition to these industrial regions on the margins of the

Pennine Upland, there is Macclesfield, farther south in Cheshire and beyond the productive coal area, where silk and artificial silk have replaced cotton and become the staple productions. Also, in the higher parts of the Pennine valleys above the outcrop of the Coal Measures, are smaller centres where the cotton industry has managed to survive in spite of the lack of coal in the immediate neighbourhood because of the situation on suitable streams.

The Wigan and St. Helens Area.—The westernmost portion of the Lancashire coalfield is situated in a lowland area away from the upland streams by which the cotton industry grew up. It stretches south-westward towards the Mersey estuary, and south of St. Helens the dip of the coal-bearing strata is exceptionally regular, and has allowed mining to extend through the cover of New Red layers so that the pits are within a few miles of Widnes on the Mersey. The industries of this and other estuarine towns are largely carried on with the aid of the coal from this coalfield, and on the coalfield itself there are both small and large centres where manufacturing has been added to mining.

Wigan is the most important centre of coal-mining and also has an iron industry, while a certain amount of cotton spinning and weaving has extended into the neighbourhood of Wigan and Leigh. The largest town on the coalfield is St. Helens, at which a group of metallurgical works is established, producing wares of the more valuable minerals, such as copper, tin and aluminium, and here there are also glass works.

The Cotton Region of the Ribble Basin.—In the detached area of the Burnley coalfield there are somewhat similar conditions, both physical and social, to those already described in connexion with the cotton manufacturing area of South-east Lancashire. This smaller coalfield occupies a trough in the Coal Measures on the north-west side of the Rossendale anticline; it is drained by two tributaries of the Ribble, which itself has a course almost parallel to the coalfield a few miles farther to the north-west. The long hollow is approximately limited by the 600-foot contour, except where the two tributaries leave the trough to join the Ribble.

As in the cotton region on the south side of the Rossendale Fells, so here the chief centres grew up where streams from the hills entered the lower and flatter country; here, too, the waters

are soft, for the streams derive their supply largely from the Millstone grit of the Fells. As in the more southern region, so here the earlier water-power was replaced by coal and the earlier woollen material by cotton; moreover, in Nelson and Colne, the towns of the north-western portion and in closest contact with Yorkshire, a worsted industry has survived, together with the manufacture of cotton piece-goods. In the main this "Burnley basin" region specialized in the weaving of cotton, though spinning is also carried on, particularly at Blackburn. At this town there are also dyeing and bleaching works, and at Accrington there is much calico printing. The lack of balance as between men's and women's labour in the cotton industry is even greater in the Ribble basin district than in the more southerly area because of the larger amount of weaving, but to some extent the disproportion is offset by coal-mining and engineering. These are important, especially in the Burnley district; at Accrington the metal trades have become as considerable as the cotton industry.

The total population in the industrial centres of the Burnley basin amounts to rather over a third of a million, and throughout this region it now shows a decline.

Preston, situated near the mouth of the Ribble in the coastal lowland, may be regarded as an exclave of the Burnley basin industrial region. Although its coal has to be carried several miles and its water drawn from the uplands to the north-east, Preston has a good commercial situation where the main north-south coastal route crosses the Ribble, and the river channel has been deepened so that large cargo steamers can reach the dock. A well-balanced group of industries has grown up: besides both the spinning and the weaving of cotton, there are several branches of engineering including the making of electrical machinery, motor-lorries and other forms of transport. With a later development than the other manufacturing towns of Lancashire, and with open country to facilitate building, Preston has not suffered from the bad housing conditions common elsewhere, and also it has not suffered so severely from the prevalent post-war changes.

Merseyside.—Along the banks of the Mersey numerous important settlements have been made, and here Liverpool, after London the greatest port of Britain, has grown up. Although the inner part of the bottle-shaped estuary is shallow, the mass

of water sweeping in and out with the tides scours the channel near the narrow entrance. At this point a slab of sandstone, the "Liverpool plateau," rises almost island-like from the low and often naturally marshy land on the north-east side of the estuary, thus giving a dry site for occupation a few square miles in extent. A small creek, the "Pool," extended from the river into this plateau and afforded a small harbourage which marked the beginnings of the port of Liverpool.

The position, however, was relatively remote from the world of men until recent centuries, and Liverpool was for long only a small fishing port with a little trade with Ireland. But with the development of Atlantic commerce, at first largely with the West Indies, and the growth of industries and population in the Midlands and north of England, the position of Liverpool assumed very great importance; moreover, the "Cheshire Gate" between the Pennines and the Welsh Uplands allowed a relatively easy route to London, and so made Liverpool a convenient entry for North American communication with the metropolis.

The "Pool" soon became useless for the growing traffic; it was filled in, and docks have been constructed along the waterfront till they form a line over 6 miles long from the southern end of the plateau northward even past the mouth of the estuary. But meanwhile congestion on the Lancashire side led to the use of the somewhat similar "Wallasey Pool" on the Cheshire side, and adjoining this inlet the sister-borough of Birkenhead grew up. Although this settlement has remained independent of Liverpool, the docks on both sides are administered by the Mersey Docks and Harbour Board, and tunnels for road and rail traffic and numerous ferries join the eastern and western portions of the conurbation known as "Merseyside."

The total trade of the port is about half that of London, and there is a closer correspondence between the amount of exports and imports than is usually the case in Britain. The nature of the trade well reflects the position of the port in relation to the industrial regions of Lancashire, Yorkshire and the Midland counties, for the chief exports are cotton yarn and goods, and after them come woollen yarn and goods; other textiles and clothing; iron and steel goods and machinery; chemicals; china, glass and pottery ware. Similarly, raw cotton heads the

list of imports (judged by values). Other materials imported for manufacture include wool ; oils, oil-seeds and oil-nuts ; metals and metallic ores ; timber ; rubber. Not only the neighbouring industrial regions of England but the whole country obtains a part of its food supply through the port of Liverpool, e.g. wheat and wheat flour, animals and meat ; tobacco is another very considerable import. The origin of these commodities clearly indicates the large amount of trade which is done with North and South America.

As might be expected, industries have developed in connexion with the commerce, and as the trade itself has tended to go to the Lancashire side whence inland communications are on the whole easier, the industries have found more room by the Cheshire shores ; on both sides, however, are carried on flour milling, oil pressing and cattle-cake preparing, soap making, etc. Since in Liverpool the warehouses have occupied most of the narrow space between the docks and the city, a recent tendency has been to develop industries in the lower ground on the north-eastern margin of the settlement, while on the Cheshire side, they have spread along the southern side of the estuary as at Port Sunlight and Ellesmere Port. Residential areas have extended still farther from the older centres, particularly north of Liverpool along the coast, north of Birkenhead in the borough of Wallasey which includes New Brighton, and even across the Wirral Peninsula to the estuary of the Dee, which has the advantage of being to the windward of the conurbation. The water supply of Liverpool is drawn from Lake Vyrnwy, formed by damming-up the head-stream of the Vyrnwy tributary of the Severn in Central Wales.

In Liverpool, as in the other great cities of Britain, economic growth has resulted in the establishment of a University and other institutions to meet the intellectual and technical needs of the citizens. Here, too, the twentieth century has seen the beginning of the building of two great cathedrals, one Anglican and the other Roman Catholic, which may give to a relatively new city architectural distinction comparable with that of the cities of greater antiquity.

The population of Liverpool and Birkenhead together now amounts to about one million persons, while the other parts of the conurbation add another quarter of a million. In spite of the recent decline in shipping generally, and particularly in that

connected with the cotton industry, the population is still increasing. Moreover, the improvements in the central areas have necessitated the outward movement of their crowded populations and thus increased the advance of the towns over the surrounding country.

Above the estuary, the River Mersey has facilitated the growth of two other centres of industry. The lowest bridges now cross between the twin towns Widnes and Runcorn, at which there are metallurgical works and great chemical industries. While coal can be easily obtained from the neighbouring Lancashire field, salt is brought from the Cheshire deposits by means of the Weaver canal which enters the Mersey at Runcorn. A few miles higher up the river is Warrington, which until recently was the lowest place at which the river could be bridged and consequently was on the main route from the south to north-western England ; here again, situated between the coal and the salt, are chemical works, and facilities for importing the raw materials have aided the growth of soap works and great tanneries.

The Agricultural Regions.—The *Plain of Shrewsbury or North Shropshire Plain* is drained by the Severn between its exit from the Welsh Uplands and its gorge through the Wenlock-Wrekin Uplands at Ironbridge. In pre-glacial times the river flowed from its Welsh exit northwards to the Irish Sea through the Cheshire region to which the North Shropshire plain is essentially related. But the damming of the Cheshire lowland by the ice turned this portion of the Severn basin into a lake bounded on the south by the Wenlock-Wrekin Uplands, and finally the water escaped by an overflow at Ironbridge and the river cut a gorge much as the Yorkshire Derwent did near Malton. As a consequence the New Red sands and marls of the plain are largely covered by glacial deposits, and the soils are very varied. Moreover, as this region, although situated in the west of England, lies in the lee of the Welsh Uplands, it has a moderate rainfall and its temperatures are neither extreme nor markedly equable. Its physical conditions therefore allow a wide range of farming, and its agriculture is well balanced ; a considerable proportion of the land is arable, and both cattle and sheep are kept in fair numbers. The resources of the region are mainly agricultural, and only a very little coal is obtained from the Coal Measures south-west of Shrewsbury. This city is

situated within a marked loop of the Severn as it meanders through the plain ; the river formed an almost complete moat around the settlement which grew up under the protection of the castle—one of the series built along this borderland of the Welsh Marches. Shrewsbury is now a railway junction and a market-town of some importance.

The West Cheshire Plain.—The present watershed between the Severn on the south and the Dee and Mersey river systems on the north is formed by a belt of morainic country, with irregular drainage and many small meres. This morainic belt forms a natural boundary separating the region of the Plain of Shrewsbury from the regions of the West and East Cheshire Plains. On the north-west side of this barrier the Dee meanders across an area, low and flat in the centre, where a deposit of stiff boulder clay covers the New Red sands and marls. The soil is generally a strong loam, and as the region has a rainfall of about 30 inches or more, much of the land has been laid down to grass. The farming is very largely directed to cattle-breeding and the keeping of dairy cattle, milk and cheese being the chief products. Pigs are also reared in considerable numbers in connexion with the dairying. On the margins of the West Cheshire Plain, however, conditions are different.

Along the western border is another morainic belt which forms a foot-hill region, transitional to the Welsh Uplands ; this area is actually in the Welsh counties of Denbigh and Flint. Below the morainic cover, Coal Measures occur between the older rocks of the uplands and the younger ones of the plains, beneath which they disappear ; they are probably continuous with the Coal Measures of the south-western Pennine margin at depths too great for working. This North Wales coalfield is a small one, extending in a belt north and south of Wrexham ; the coals are of the steam, gas and house types, and are sent away for use elsewhere.

In the northern part of the plain stands Chester, once at the mouth of the Dee. The funnel-shaped estuary is not kept clear of silt by the tidal sweep as is the bottle-shaped estuary of the Mersey, and its upper part has already been filled in ; now a straight cut leads the waters of the Dee through reclaimed salt marshes utilized as pasture for flocks of sheep.

In Roman times, Chester was a focus of military roads and the terminus of Watling Street, and in the Middle Ages it was a

port trading with Ireland ; it now offers much interest in the still-remaining Roman walls and fine half-timbered houses.

The Wirral Peninsula has varied soils, partly of boulder clay and glacial gravels and partly of emergent sandstone ; its farm lands are being invaded by settlements around which market gardening is extending to take advantage of the local markets.

The eastern boundary of the West Cheshire Plain is formed by a broad ridge of Triassic sandstone ; this stands up steeply, and sometimes precipitously, above the lowlands and at one point reaches over 700 feet. While partly forested it is also utilized for intensive agriculture, and in both respects, as well as in its elevation, contrasts with the surrounding, mainly pastoral country.

Consequently the *Central Cheshire Ridge* forms an independent stow, and one which cannot be included either in the West Cheshire tract or the East Cheshire tract. It is an example of an "inter-regional" stow,¹ which separates tracts with which it cannot be incorporated ; such inter-regional stows form an exception to the rule that regions of lower order can be included in those of higher order. Most inter-regional stows are valleys worn down from uplands which they separate, the Goring Gap between the tracts of the Chiltern and the White Horse Hills illustrates this type. The Central Cheshire Ridge belongs to the less common class of upstanding, residual stows separating lower tracts, which have either been worn down or have subsided as the result of crustal movements.

The East Cheshire Plain.—Like its West Cheshire counterpart, this tract is glaciated, but sands occur over wide areas and the soils are therefore often much lighter. Dairying is less exclusively the aim of the farming, and potato-growing assumes more importance. The region has an additional resource in the salt deposits found in the beds of rock-salt in the New Red marls ; the main production is near Northwich and Middlewich and associated with it are chemical industries.

The position of the region gives it some commercial importance, for it forms part of the "Cheshire Gate," and the main road and rail routes from the south and Midlands of England to the north coast of Wales and the north-west of England pass through it. Crewe is one of the most important railway junc-

¹ For suggesting the term "inter-regional stow," the writer is indebted to Dr. B. G. Brasington.

tions of England, and the railway construction and repair shops which were erected here were the primary factor in the growth of the borough.

The Lancashire Plains.—The southern part of this tract may be taken as comprising all the lowlands of the Mersey Basin (though the district south of the river is in the county of Cheshire), and also the plain between the estuaries of the Mersey and the Ribble. It has been heavily glaciated, and streams have spread gravels over much of the boulder clay. On these deposits peat accumulated, and many areas still bear the name “moss,” although the peat bogs have been reclaimed. By drainage and thorough cultivation, a loamy soil has been formed, and even though the rainfall is relatively heavy there is a fair amount of cereal production. A four-course rotation is commonly followed: (i) potatoes, (ii) wheat, (iii) grasses, (iv) oats. The potatoes do particularly well on the naturally peaty soil, and this region and the peaty areas of the Fenlands are the largest producing districts in Great Britain.

Around and between the big towns, the land is more largely devoted to permanent grass with a view to dairy farming, or to market gardens.

Off the gently shelving coast, wide stretches of sand are exposed at low water; the sand is driven on-shore by waves, and the prevailing westerly winds, often strong, have built it up to form sandhills, shown on the geological map as of “recent” formation. On this coast, Southport has grown up as a “dormitory town” and pleasure resort for the workers in Liverpool and the industrial areas.

North of the Ribble valley, the plain is again narrow because of the western extension of the Pennine Upland known as Bowland Forest. The lowland at the foot of the hills is covered with a heavy boulder clay utilized almost entirely as permanent pasture. Beef cattle and dairy cattle are kept in considerable numbers, and as in Cheshire much pig-rearing is associated with the dairy-farming; sheep, too, are more numerous than in south Lancashire. Cereals are of very little importance, oats alone being adapted to the progressively lower temperatures and higher rainfall experienced in the more northerly districts.

The Fylde is the name given to the peninsular lowland north of the Ribble estuary. The soils are loamy, and there are areas of reclaimed “mosses” on which vegetables are grown and

animals reared. Along its northern and southern shores there are sandy areas, between which the large pleasure resort of Blackpool has grown up, while by a sheltered inlet on the northern side there is the small port of Fleetwood, at which more fish are landed than at any other port on the western coasts of Britain.

North of Bowland Forest, the lowland is formed by the lower valley of the Lune and the east coast of Morecambe Bay.

The area near the mouth of the Lune has had some commercial and strategic importance, for it is the narrow gateway, between the sea on the one side and the uplands on the other, where the English Plain ends on the "West Coast route" to Scotland. In Roman times Lancaster, at the bridge-place of the Lune river, was a military station, but now its importance is rather that of a railway and market centre; Preston has taken its position as the seat of administration for Lancashire because of its greater growth and more central position in the county. A few miles to the west, Heysham is a small port placed where a relatively deep channel through the shallows of Morecambe Bay gives access to boats engaged in the ferry traffic across the Irish Sea.

This area may be regarded as the last portion of the English Lowland, for on the north side of Morecambe Bay the small areas of lowland are mainly in the valleys of the rivers of the Lake District and are best considered as being parts of that region.

CHAPTER X

THE ENGLISH LOWLAND— A REVIEW

IT will be useful at this point to devote a short chapter to a review of the English Lowland as a whole ; we may now note the general pattern formed by the regions which have been studied piecemeal in the preceding chapters, and suggest their classification into types.

The Pattern of the Regions.—Broadly speaking, the south-eastern part of the English Lowland is formed of scarp-lands. These are areas of limestone or chalk, sandstone or clay, which have been slightly tilted or bent and then either etched out to the form of low plateaus with a scarp on one side, as in the case of the more resistant limestones, sandstones and chalk, or worn down to plains as in the case of the less resistant sands and clays ; the lowest areas of all were once under the invading shallows of the sea and have now been reclaimed.

The scarp-lands extend from the edge which generally faces westward or north-westward, and can be traced more or less continuously in a belt from the coast of Lyme Bay in Devonshire to the coast of the North Sea in Yorkshire. The greater part of this edge is the scarp of a belt, mainly composed of limestone, which runs as far north as the Humber, and it is convenient to refer to this belt under the general term of the *Midland Limestone Belt*. North of the Humber, however, the limestone does not appear in the same way, and its place is taken by the *North York Moors* which are composed largely of sandstones.

The limestone belt dips eastward, and almost throughout its length disappears beneath a second belt, a lowland mainly formed of clays. This area comprises first the *Oxford Clay Vale* and the *Bedford Lowland* ; then its continuity is broken by the sag occupied by the *Fenlands*, after which it reappears in the *Lincoln Clay Vale* ; considering it as one tract-group, we will call it the *Midland Clay Belt*.

The clays similarly dip eastward, and for the most part dis-

appear below the great sheet of chalk. This forms a low plateau with a scarped edge stretching almost continuously from the western part of the English Channel to the North Sea coast of Yorkshire, save where it is interrupted by the sag in the neighbourhood of the Wash. Apart from this subsidence, the chalk sheet dips more or less eastward, but in the south-east of England it has suffered three marked warpings : it has been bent upward in the Wealden anticline and, on either side, it has been bent downward under the Hampshire Basin and the London Basin. From the Wealden upfold the chalk has been worn away and the underlying strata of clays and sandstones have been exposed, while in the Hampshire and London downfolds the chalk has been covered by later sands and clays. Farther north, in East Anglia, Lincolnshire and Yorkshire, the eastward dip of the chalk sheet has resulted in its disappearance below clays, sands and silts of glacial or marine origin.

Because of the warpings of the strata in South-eastern England, the chalk lands appear to radiate from the wide area of the Central Downs of Hampshire and Wiltshire in four main directions : south-westward in the Western Downs, south-eastward in the South Downs, eastward in the North Downs and north-eastward in the White Horse Hills and the Chilterns. Still farther to the north-east, the chalk is largely covered with glacial clays and sands in East Anglia, but it reappears as downland in the Lincoln and Yorkshire Wolds.

Thus in the scarp-lands portion of the English Lowland there is, over much of the area, a general graining of the country from south-west to north-east, which is modified by :

(a) East-to-west trends in the "continental angle" where the Wealden upfold brings the chalk of England within a short distance of that of France ;

(b) A north-to-south trend in the latitude of East Anglia ;

(c) Farther north, an almost north-west to south-east trend where the strata dip below the North Sea off Lincolnshire and Yorkshire.

The remaining areas of the English Lowland, farther to the west, are not so clearly scarped, for they have been formed of strata either fairly horizontal or more involved in the geological disturbances which formed the Uplands of Northern and Western England and the Welsh Uplands.

The surface of this western portion of the English Lowland is

largely underlain by clays, marls and sands of New Red and Lias age and of approximately horizontal arrangement. They form a tract-group extending in three great arms from the Midland Plateau, viz. south-west to the mouth of the Exe, north-east to the Tees estuary, and north-west to Morecambe Bay; to these areas the general term "New Red" Plains may be applied.

Beneath a large part of these clays and sands lie the Carboniferous strata, which have been bent into a number of upfolds and basins of various sizes. In the centre of the region are the upfolds and upthrusts of the Midland Plateau region where the Carboniferous rocks appear in a group of small coalfields. Against the central and northern part of the Welsh region, the Coal Measures rise to the surface in the coalfields of Shropshire and North Wales. Connected with the disturbances which led to the formation of the great coalfield of South Wales (beyond the English Lowland) are the Forest of Dean and Bristol coalfields.

The larger English coalfields are related to the upfold of the Carboniferous strata in the Pennine area. Where these strata are bent up on either side of the southern part of the Pennine Upland, Coal Measures are exposed and coalfields have developed which in the east have also extended far below the bordering New Red layers; thus have originated the great York, Derby and Nottingham coalfield, that of Lancashire and Cheshire, and the smaller one of North Staffordshire.

In the north part of the Pennine area, the Northumberland and Durham coalfield has a structure broadly similar to that of York, Derby and Nottingham, but in the north-west the dislocations of the Lake District have led to the formation of the small Cumberland coalfield within a region which is distinct from the English Lowland, and will be discussed in a later chapter.

It will be observed that the coalfields grew up where the Coal Measures lie near sea-level, i.e. neither upfolded to such heights that they have been worn away nor downfolded to such depths that they are hidden beneath thick strata of later origin. The concealed coal-basin of Kent is an exception to this rule, as it is exceptional in its situation, and it remains to be seen whether its depth will prevent its economic development. The generalization may therefore be made that the northern and western

portion of the English Lowland is formed of plains arranged in three long "arms," interrupted by the emergence of older rocks, which in parts have caused the growth of coalfields.

The Types of Regions.—While the general pattern of the regional arrangement is determined by the geological structure and surface conditions, the *position* of the regions greatly affects their development and therefore their characteristics and classification. The position has two main influences: first, upon the climate and therefore upon the agricultural utilization of the land, and second, upon the commercial and industrial activities of the people.

As regards climate, the most marked contrast is between west and east, the former having more rain and cloud, the latter being drier and sunnier. To these differences correspond the commoner types of farming: in the west the keeping of cattle is the main aim, the greater part of the land is under permanent grass, and oats constitute the chief cereal crop; in the east, arable land generally predominates, wheat and barley are important products and the number of sheep greatly exceeds that of cattle.

The largest centres of commerce have developed where estuaries provide convenient entry into the country from the great routes of overseas traffic. The Mersey on the west and the Humber on the east lead to the coalfields of Lancashire and Yorkshire; the neighbourhood of these entries has also stimulated industrial and commercial activity upon the coalfields, and has therefore been a factor in the development of very great conurbations. In Northumberland and Durham, however, in spite of the proximity of the coalfield to the sea, the industrial development has been more specialized and smaller, and to this limitation the more remote position of the region has contributed. The Midland coalfields lie at some distance from the great estuaries, and it is significant that the Black Country, after the period in which England was the unchallenged "workshop of the world," had to transfer its production to the lighter articles in which cost of transport is not a serious handicap.

The Bristol Channel, in so far as it is an entry to the English Lowland, has lost its relative importance since the north became populous. The Thames estuary, on the contrary, has maintained its position as the greatest commercial entry of Britain, partly because of its neighbourhood to the Continent and

partly because of the fact that at its head is the metropolis, with its enormous population, with rail- and roadways leading to all parts of the country, and with a great and varied industrial development. Southampton Water has a more specialized commerce connected with rapid forms of transport.

While the coalfields and the neighbourhood of the great ports have been the chief factors affecting the distribution of the larger industrial areas, smaller manufacturing centres are scattered along the main lines of communication, even in areas which are predominatingly agricultural.

Thus the characteristics of the regions constituting the English Lowland are the combined results of many factors, and when they are grouped into *types* the pattern which these types display is more complicated than the pattern which depends only upon the geological structure. The following concise statement of the groups indicates their more outstanding characteristics.

(i) *The Chalk Tracts* form a large connected group in Southern England, together with the detached pair situated on either side of the Humber. They are of low, tilted plateau form; their soils are generally rather dry and thin except where the chalk is covered with an impermeable clay; they are largely open grasslands or cultivated areas on which sheep-rearing and the growing of grain are the main occupations, and consequently they have a more scanty population than most of the English Lowland.

(ii) *The Midland Limestone Belt* (including the South-west Scarplands) is a group of tracts which are somewhat akin to the chalk tracts, because of their similar geological composition, and in the higher parts the work and way of life of the inhabitants resemble those of the chalk country.

(iii) *East Anglia* is another tract which has some similarities to the chalk regions, but the widespread covering of chalky boulder clay adds to the fertility of the soil, and with the favourable climate it allows a high proportion of arable land on which barley and wheat are produced in large amounts; for an almost purely agricultural region, the population is relatively dense.

(iv) *The London and Hampshire Basins* are lowlands of slight relief, in which there are rather infertile clayey and gravelly soils, but also loamy areas with greater agricultural productivity. The larger settlements are based, directly or indirectly, upon the

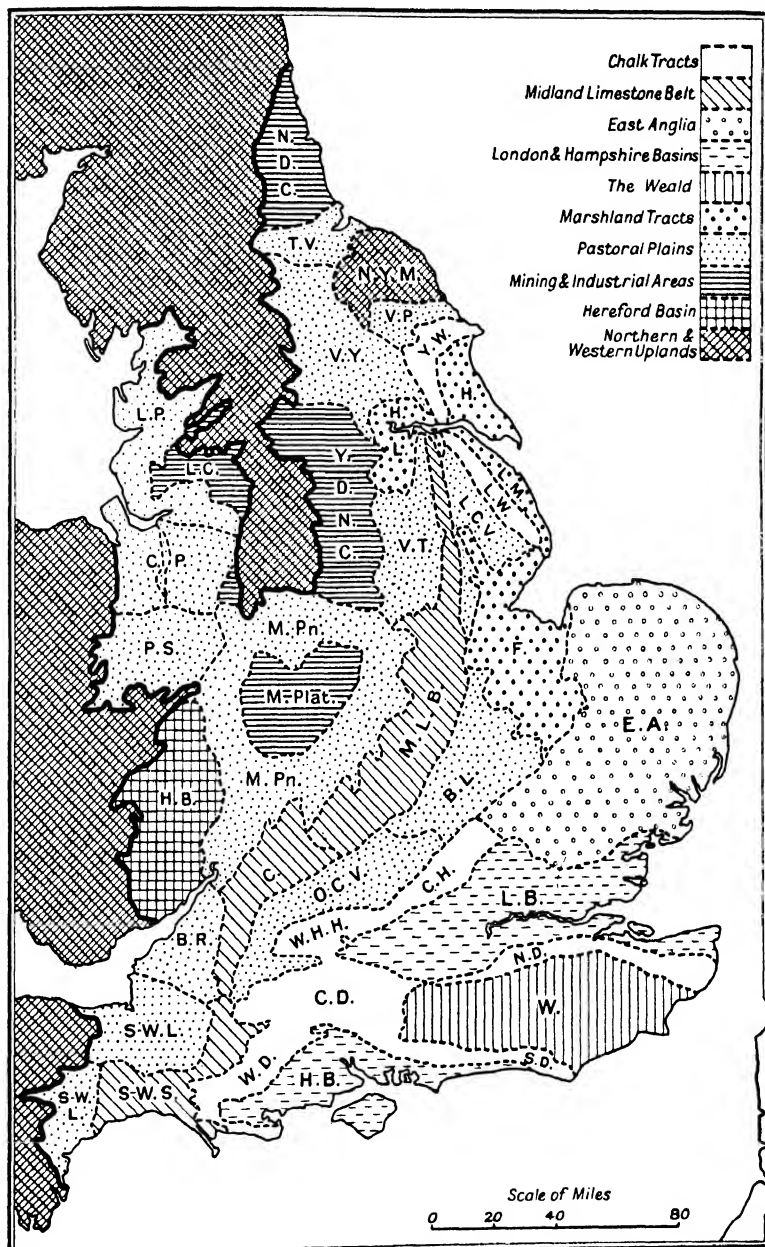


FIG. 38.—REGIONAL TYPES OF THE ENGLISH LOWLAND.

commerce attracted by the estuarine entries, and in the case of the London Basin, the metropolis has grown to such an extent that it has completely transformed part of the region and greatly influenced most of the remainder.

(v) *The Weald* is a tract of varied relief and character due to the juxtaposition of the layers forming the denuded anticline ; with its favourable climate the more fertile soils are productive but the less fertile remain as woodlands or grasslands and support few people.

(vi) *The Marsh-land Tracts*.—Of this tract-group the most characteristic is the Fen District, and closely akin are the Humber-head Levels ; these two main tracts are virtually connected by the Lincoln Marshland and Holderness, which have required less complete reclamation. All are now productive regions, yielding to intensive agriculture a variety of crops, including much wheat. Important commercial settlements have arisen on the shores of the Humber.

(vii) *The Pastoral Plains*.—The Midland Clay Belt and the “ New Red ” plains, together with the Vale of Pickering, are all similar in having low relief, a rainfall which is fairly considerable except in the easternmost tracts, and mixed farming in which the keeping of cattle is very important and oats generally form the chief cereal crop, though wheat and barley are also noteworthy in the drier regions. In addition to the agricultural settlements and market centres, there are a number of inland towns of moderate size in which commercial and industrial development is due to position on important routes and consequent rapid and cheap transport. Considerable trading and industrial towns have also grown up by the Severn and Tees estuaries, and the great conurbation of Merseyside occupies much of the plain between “ Liverpool Bay ” and the western end of the South Lancashire coalfield.

(viii) *Mining and Industrial Areas*.—Coal mining is the common characteristic of these regions, but while in some parts it is carried on only by the side of agriculture like that of the neighbouring Pastoral Plains regions, in other parts the mining has led to the growth of industries and commerce ; the form of industrial development varies from place to place and the aspect and prosperity of the areas show corresponding variations. While the simple mining communities are relatively small, the industrial and commercial areas have become densely populated,

and include the larger conurbations of England with the exception of the metropolis and Merseyside. The Midland Plateau, although a composite tract, may be included among these regions; on the other hand, the small coalfields of the western margins of the English Lowland (in North Wales, Shropshire, the Forest of Dean and the Bristol region) are not of sufficient significance to rank as tracts of this type.

(ix) *The Hereford Basin* is a composite tract, including a fertile central area and, on the margins, upraised masses of differing characters.

Within the English Lowland are also a few exclaves of the northern or western Uplands; of these the *North York Moors* tract is the largest.

If the above classification of the various regions of the English Lowland is accepted, the tracts appear to fall into nine types each of which has certain common characteristics. Such a generalization has its uses, but the fact must not be overlooked that every tract is composed of a number of stows, each differing in some ways from its neighbours, and that a particular stow in one tract may closely resemble a stow in some other tract which may be, in general, of a different type. Thus the Romney Marsh stow in the Weald tract and the Plain of Somerset stow in the South-west Lowlands tract are in many ways alike, and both rather closely resemble the Fenland tract. Yet, on the other hand, sheep-rearing is the predominant occupation in Romney Marsh, dairying in the Plain of Somerset and intensive agriculture in the Fenland.

If the individual stows were all marked on a large map of the English Lowland, and they were classified into stow types irrespective of the tracts to which they might be assigned, a very large number, both of stows and also of stow types, would have to be indicated, and the resulting pattern would be very complicated. It would, indeed, be too complicated for any generalization to be made which would help one to realize the broad distributions and the general character of the country.

The English Lowland as a Unit.—The method of assembling the stows into tracts may be extended by assembling the tracts into the unit-area of the English Lowland, which being a region of the third order may be termed a sub-region. That this part of the Earth's surface is indeed a unit-area, in spite of the differences between its constituent parts, may be realized by

stating its common characteristics, and contrasting them with those of the more westerly and northerly parts of Britain.

With small and relatively insignificant exceptions, the English Lowland is an area of slight relief, mainly of plains and low scarp-lands, formed upon strata of generally weak resistance to weathering and stream action ; a geologically recent change in the relative level of land and sea has resulted in the formation of wide estuaries at the mouths of the larger rivers.

Its climate is temperate, with fairly hot summers and a moderate rainfall, and these conditions have permitted cultivation of the greater part of the soils ; mixed farming is the common type of land utilization, including the growing of cereals and of fodder crops for sheep, cattle and other animals.

From the Carboniferous strata which outcrop in the more westerly portions, coal is mined in large amounts and on the larger coalfields important industries have grown up, while the estuaries are the scene of great commercial activity.

The development of the resources has made possible the growth of a great population ; on a total area of about 40,000 square miles live 37 million people ; the resultant density of population, about 925 persons to the square mile, is equalled by few other regions of similar size in any part of the world. The rural areas are least densely populated, and the number of people engaged in agriculture is declining ; the areas in which industry and commerce predominate are among the most crowded in the world, and in the main even yet have an increasing number of people ; the metropolitan area far exceeds the other great urban areas in the total number and also in the rate of increase of its population.

How the English Lowland differs, in the broad characteristics of its relief, resources and population, from the remaining areas of the British Isles will be considered in the succeeding chapters.

CHAPTER XI

THE WELSH AND DEVONIAN PENINSULAS

WE may now study the western and northern regions of the British Isles, which contrast markedly in a number of ways with the English Lowland of the south-east. The region to which we give the name of the Welsh Peninsula almost coincides with the Principality of Wales; it is mainly upland, and well illustrates the differences, in several important respects, between the English Lowland and Northern and Western Britain.

Wales : General Structure.—In the first place, the Welsh Peninsula may be studied as an example of “block structure.” Its uplands do not show the characters of ranges due to simple upfolds of the strata, but there are wide plateau-like areas upon which rise various “chains” or “domes” to mountain heights, and cut by deep valleys. The relief often shows a parallelism, indicating a graining of the land: in Northern and Central Wales the features usually run from south-west to north-east, e.g. the Menai Strait between Anglesey and the mainland; the Llyn Peninsula of Carnarvon and its north-eastern continuation in the high mass of Snowdonia; the deep valley which drains south-westward to Barmouth on Cardigan Bay and north-eastward by the upper Dee through Lake Bala; the trend of the South Shropshire Uplands and especially of Wenlock Edge; the upper valleys of the Teifi in Cardigan and the Towy in Carmarthen. In South Wales, however, the graining is from west to east, e.g. the trends of the coast-line showing themselves in the general direction of Milford Haven in Pembroke and the Gower Peninsula between Carmarthen Bay and Swansea Bay.

The geological map shows the same two directions in the structure of the rocks, especially clearly in the north in Anglesey, and in the south where there is a long belt of Coal Measures, extending from west to east across Pembrokeshire until interrupted by a subsidence in Carmarthen Bay, and then continued across Glamorgan as far as the Usk valley.

The reasons for these two directions in the relief and structure

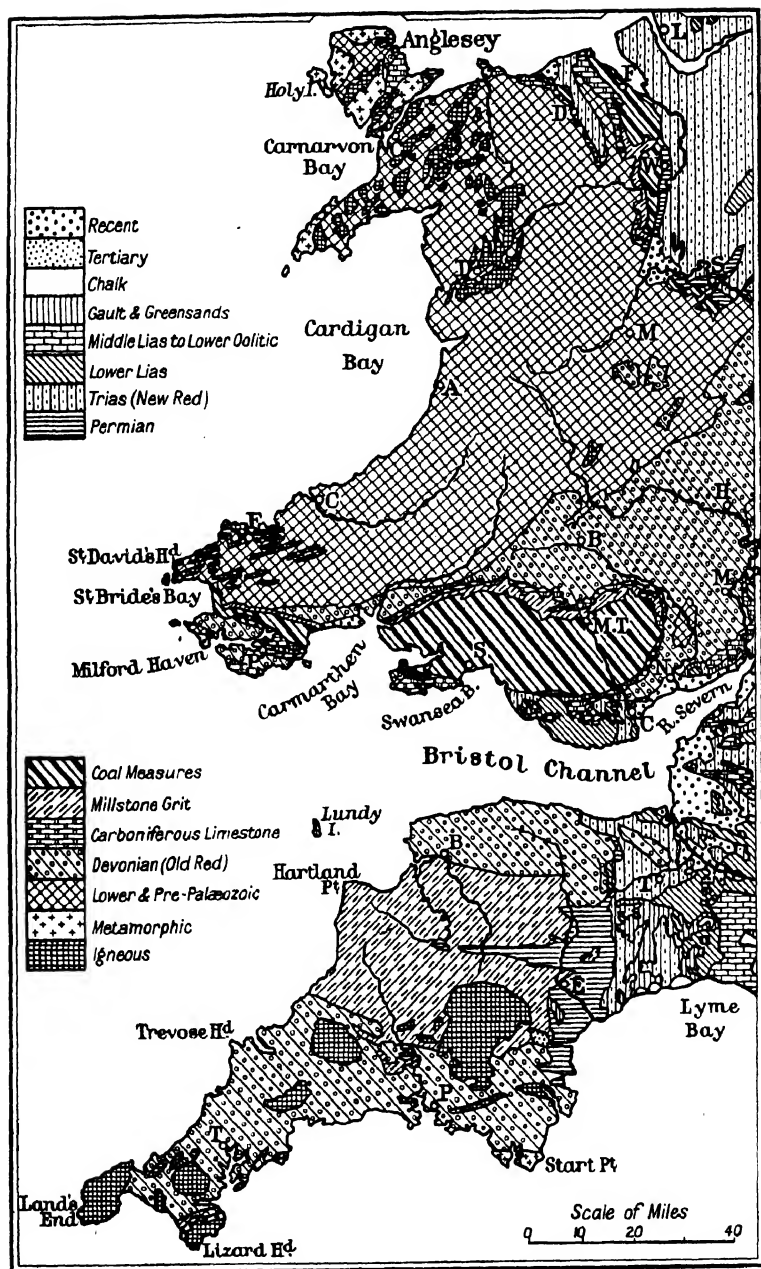


FIG. 39.—GEOLOGY OF THE WELSH AND DEVONIAN PENINSULAS.

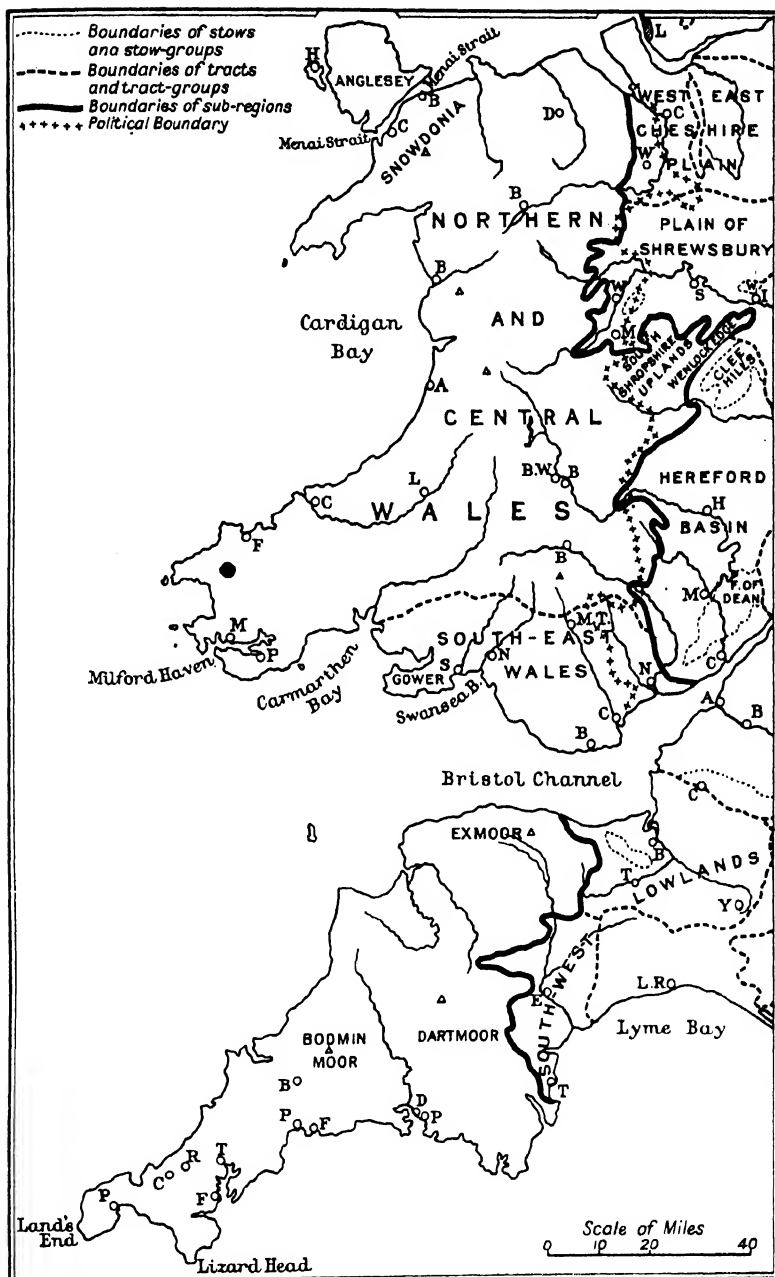


FIG. 40.—REGIONS OF THE WELSH AND DEVONIAN PENINSULAS.

of Wales, as well as for several other characteristics of the country, may be understood when some of the most important features of the geological history of the region have been described. We will first consider the area of *Northern and Central Wales*, and must go back to the middle of the Palæozoic era. The rocks already formed at that time in this part of the earth's surface, i.e. the early Palæozoic and pre-Palæozoic strata, were folded into mountain masses with a general south-west to north-east direction. These mountains were part of a large system which included the present area of Scotland, and have therefore been termed "Caledonian"; the earth movements which gave rise to them are also termed "Caledonian" and, as the geological table in Appendix I shows, occurred about the beginning of the Devonian period. Consequently the mountains were formed of these bent and contorted rocks, including sedimentary ones such as hard grits and shales, metamorphic rocks such as quartzites and slates, and igneous rocks such as volcanic lavas and agglomerates.

The mountains formed at this epoch are not, however, those of the present time, for in succeeding geological periods they were worn down to the condition of a peneplain, only the hardest portions, e.g. some of those formed by slates and volcanic material, standing much above the sea-level of those times. At this stage the almost level region would show strips of the various strata outcropping along the surface in the direction of the previous mountain folds, as the grain of the wood shows in a tree trunk sawn longitudinally.

Later, the peneplain was again affected by earth movements; it was broken and the levels of the fragmented areas were changed, some being upraised to plateau-form. In these, the rivers were rejuvenated and resumed their work of erosion, etching out the less resistant streaks of rock more than the harder parts, and thus revealing the grain of the land in the relief. The faultings which accompanied both the original folding and the later fragmentation of the rocks also produced lines of weakness in the structure, and along these, as along the less resistant strata, weathering and streams were able to erode valleys relatively rapidly. In such wise the plateau was dissected, the grain of the land and the direction of the faultings becoming visible in the surface forms.

Areas in which the Caledonian trends are still to be seen are

marked in Fig. 58, showing the structural relations between Britain and the Continent.

In the case of Wales the process was further complicated because there was more than one period of uplift, and in different parts the surface attained different heights. The central portion appears to have been raised higher than the rest in the more recent uplifts, and here the general level of the plateau is now more than 2,000 feet above the sea. In North-western Wales, among the rocks are very resistant masses of volcanic lavas, which even in the stage of the peneplain were never worn down so much as the sedimentary rocks and after the uplifts have remained above the general level¹; such is the case in Snowdonia, where the great, irregular cone of Snowdon rises to over 3,500 feet, and again in the high ridge of Cader Idris which reaches nearly 3,000 feet. The latter mountain mass has a particularly striking appearance, because it stands immediately above the deep trench behind Barmouth. This trench, continued, as stated above, in the valley of the upper Dee, has been cut by rivers along a line of weakness due to a great fault following the main direction of the ancient mountain folding.

The general level of the plateau becomes lower towards the south-west of Wales, most of the country on the south side of Cardigan Bay being below 1,000 feet, while even the ridges of igneous rock in the north of Pembroke do not reach 2,000 feet.

Cardigan Bay itself and the Irish Sea as a whole represent areas of subsidence, and it is characteristic of all the "Caledonian" mountain regions that while some parts have been uplifted to plateaus, others have sunk and have let in the waters of the ocean; the land areas are therefore generally large peninsulas or even islands. This accounts for the general form of the north-western parts of the British Isles. Moreover, a comparatively recent and slight change in the relative levels of land and sea has allowed the sea to penetrate the valleys, and so produced a very irregular coastline with many smaller peninsulas and islands, and the corresponding inlets and straits.

In the Ice Age, heavy precipitation upon the Welsh uplands took the form of snow from which an ice-cap accumulated and pressed outward as shown in Fig. 14. Many of the valleys were scooped out by glaciers, being deepened so that they had a

¹ Residual heights of this kind are known as monadnocks, from the name of such a mountain in New England.

U-shaped section ; in some cases glacial lakes have been formed. Another result of glaciation is the deposit of boulder clay which covers not only the lower lands but also considerable areas of the plateau.

In *South Wales*, there is a somewhat similar evolution, but the rocks and the earth movements are both of later date. In this part the upper Palæozoic rocks were deposited after the more northerly regions had been raised to form land areas, and a succession of strata was laid down in the south : Old Red sandstone, Carboniferous limestone, Millstone grit and Coal Measures. At the close of the Carboniferous period came another epoch of earth movements called "Hercynian," in the course of which these strata were bent into folds which in South Wales had a general west-east trend. The folds extended also over the region now forming South Ireland, and there the direction changed to a curve tending to the south-west (see Fig. 58), while on the other side of the Welsh region the direction was rather to the south-east ; to the dislocations in the last area is due the uplift of Carboniferous limestone which appears in the Mendip Hills. Farther south, the foldings show themselves in the Devonian Peninsula and again in Brittany ; the whole series of approximately west-east folds has been called *Armorican* from the ancient name of the last region.¹

As a result of the Hercynian foldings, the Old Red strata and all the Carboniferous rocks of the South Wales region were bent down into a long syncline running from west to east, with higher land on the north and the south. When denudation took place the Coal Measures, being the uppermost strata of the system, were worn away from these higher areas, but were preserved in the relatively low bottom of the trough, and a peneplain was formed with a grain running from west to east, consisting of a central belt of Coal Measures with the lower strata exposed to north and south of it. This is somewhat like the present state of affairs in southern Pembroke, where the belt of Coal Measures runs from St. Bride's Bay to Carmarthen Bay with strips of the older rocks on the north and south.

¹ The term "Armorican" is often used to denote the whole of the earth movements of this time, but it is perhaps best to employ "Hercynian" for this purpose, and to use *Armorican* only for the folds more or less parallel with those of Brittany, since in the Pennine Uplands, in Central Scotland and on the continent of Europe, there are others of the same period running in quite different directions.

East of Pembroke, however, there have been marked dislocations of later date; Carmarthen Bay is an area of subsidence, while in Glamorgan the old peneplain has been raised to form a tilted plateau. On the north side it rises to nearly 3,000 feet, where the hard strata of the Old Red sandstone form the great scarp of the Brecon Beacons overlooking the upper valley of the Usk. (See the geological section in Fig. 41.) From these heights the plateau sinks southwards, composed of the eastern part of the old trough with the Millstone grit and Carboniferous limestone showing near the northern side and again on the southern margin (except where this is broken by the subsidence in Swansea Bay), and between them a wide exposure of the Coal Measures forming the great South Wales coalfield.

Still another element in the structure appears in the lowland south of the coalfield, i.e. the coastal plain known as the

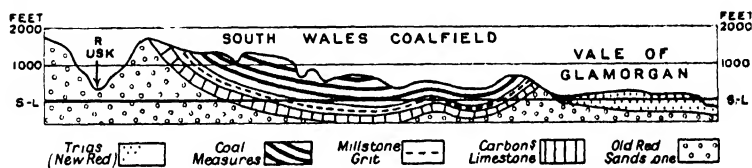


FIG. 41.—SECTION THROUGH THE SOUTH WALES COALFIELD.

The section is drawn from north to south just west of Cardiff.

“Vale of Glamorgan,” west of Cardiff. This projecting low area must be considered as a part of the Severn valley, not involved in the sinking which has depressed the lower part of this valley below the waters of the Bristol Channel, and much of the Vale of Glamorgan is floored by strata of Lias and New Red age like those of the lower Severn valley.

Anglesey.—When we correlate the relief and structure with the other physical conditions and the human geography, we have the basis for the division of Wales into its constituent regions. Here we have space to distinguish only three well-contrasted areas: Anglesey, Northern and Central Wales, South-east Wales. Anglesey is a tract which differs from Northern and Central Wales mainly in the fact that it has not shared in the great uplift to plateau-form but remains a peneplain. In spite of the differences in the composition of the rocks, it is in general an undulating lowland: the more resistant areas stand at most only a few hundred feet above those which have been

worn down almost to sea-level ; while the former give sites for settlements, the latter may form belts of marsh-land. The glacial covering adds to the fertility of Anglesey, and its low elevation gives it higher temperatures and a less heavy rainfall than most of Wales. It is largely utilized as permanent grass-land, supporting mainly beef cattle, though milch cattle are also reared, as well as a considerable number of sheep. Oats are grown to a greater extent than over most of Wales, but less than in the northern parts of the English Lowland.

Railway communication from England is made possible by the Menai Bridge, and continued across the strait which separates Anglesey from Holy Island ; here stands Holyhead, whence there is a mail service to Kingstown, near Dublin, with a crossing of about 60 miles.

Northern and Central Wales.—This region must be regarded as a tract-group. In the north-east is the small valley of the River Clwyd, a trough of New Red strata, but with this exception all the block of the “Caledonian” type is formed of ancient rocks. They weather to relatively poor soils, are generally impermeable and, like the boulder clay which covers large areas, tend to be wet and on the flatter parts are often ill-drained. The rainfall is naturally heavy, for the elevation of the great mass of the plateau gives rise to “relief rains” ; except on the coastal lowlands the precipitation is everywhere over 40 inches, on the higher areas it is over 60 inches and on Snowdonia it is over 100 inches per annum.

When, in addition, one takes into account the frequency of mists and clouds, the lower temperatures of the higher parts and the steepness of the slopes on the valley sides, it will be realized that there are but small areas capable of cultivation. Consequently much of the land has a “natural” vegetation cover, in the sense that it has not been deliberately planted by man although the natural growths have been modified by the cutting down of woods, by the grazing of animals and even, in some parts, by past attempts at cultivation. At the present time large areas are rough pastures, heaths and moors, and a climb from a valley, with its fields and perhaps strips of woodland, will frequently show at first slopes clad with grass, bracken and heather, then wide, flatter expanses of ill-drained moors where sphagnum moss grows and peat has accumulated, and finally masses of rock bare except for patches of moss and lichen.

On the farm lands of the valleys and the coastal lowlands, the climatic conditions restrict the type of production, and grasses are grown where it would be difficult or impossible to ripen cereals; oats can withstand the heavy precipitation better than the other grain crops, and are grown to a moderate extent. Even root-crops occupy a very small proportion of the cultivated land. On the other hand, great expanses of rough grazing on the hill-sides and uplands are available in summer, and to these very



[Judges' Ltd.]

FIG. 42.—THE WYE VALLEY IN THE WELSH UPLAND.

The skylines give an unusually clear indication that the country is a dissected plateau. The field of grain has been formed from reclaimed marsh in the flat valley-bottom.

large numbers of sheep are sent in spring. Towards the end of summer they are returned to the valleys or sold for fattening to the English graziers or to butchers; markets are held in autumn in towns such as Welshpool on the Severn and Builth on the Wye, in the valleys which lead from the Welsh Uplands to the English Lowland. Some cattle are kept, chiefly "stores" sold into England for fattening, but the main concern of the farmers is sheep-rearing, and in consequence the agricultural population is scanty. Moreover, owing to the lack of intensive agriculture and the dependence upon much rough grazing, the

standard of living is distinctly lower than is common in the English countryside.

Other sources of livelihood in Northern and Central Wales are few : slates are quarried in Carnarvon on the north-western slopes of Snowdonia, behind the Menai Strait, and also on the south-eastern side of the same highland in Merioneth. The hard rocks are quarried for other material, such as road metal, but the ores of copper, gold, lead and zinc, which they contained in small quantities, no longer repay working to any extent.

The structure is also the reason for the existence of mineral springs, which have given rise to some inland health resorts such as Bwlth Wells in Brecknockshire, and for scenery which attracts many tourists from outside the country.

North Wales is most visited, and Snowdonia affords the grandest views. This great highland mass is divided by valleys which run both longitudinally and also transversely, and are cut so deeply that they are but a few hundred feet above sea-level. Long glacial lakes occupy many of the valleys, and mountain tarns lie on the plateaus. Great ice-scooped cirques and ridges of resistant volcanic rock diversify the mountain heights, which appear the more striking as they rise within a few miles of the coast and stand precipitously above the valleys. From the highest summits, the view extends not only over the uplands of North Wales, but on a fine day even across the sea to the mountains of the Lake District and to those of Ireland. The coasts, too, attract visitors, and there are many seaside resorts busy in the summer.

Yet the permanent population dependent upon the temporary immigrants is not great, and there are no large towns in Northern and Central Wales, the chief settlements being Aberystwyth in the centre of Cardigan Bay, and Carnarvon and Bangor by the Menai Strait.

On the Welsh side of the Dee estuary, there are small industries aided by the North Wales coalfield referred to in a previous chapter. A number of small factories producing flannel, notably in the Teifi valley between Cardigan and Lampeter, are survivals of a past woollen industry based on sheep-rearing,

Water-power is developed near Snowdon and in Merioneth in North Wales, the electric current being partly utilized in the country and partly carried by cable to Cheshire ; in this connexion it may be recalled how the rainfall on the Welsh uplands

is utilized for the water supply of English industrial towns as well as feeding the Dee, the Severn and its tributaries which flow through English territory.

Commerce is another means of livelihood handicapped in Wales by the physical conditions, for communications through the region are very difficult. Entries from the English Lowland are provided by the valleys of the Dee, the Severn, the Wye and the Usk, which penetrate the eastern part of the upland, but the routes leading through to the west do not attract traffic and are less used than those along the north and south coasts.

South-west Wales.—The differences between the south and the rest of the peninsula are largely due to variations in the structure. Although the geological map shows a narrow outcrop of Coal Measures through the south of Pembroke, there are now only very small amounts of coal produced, and the main resource of the south-west of Wales is agriculture. Moreover, this region has not been upraised to plateau-form, and therefore as compared with the rest of the country has less upland, with its limitation to rough grazing in summer, and relatively few sheep are kept. Much of the land has been sown with grass, and the permanent pastures support large numbers of cattle. These are raised mainly for beef and for sale to eastern districts, but also for dairy purposes, butter being produced and sent to the industrial regions.

South Wales has better railway communications than most of the country, for fast trains reach it from Southern England *via* the Severn Tunnel and skirt the south-eastern plateau till they get to the easily traversed south-western lowlands. This means of rapid transport has enabled Milford Haven to become an important landing-place for fish, and Fishguard on the north coast of the Pembroke peninsula is a ferry-port for quick passage to Southern Ireland, the distance across the Irish Sea here being a mile or two shorter than from Holyhead. The town of Pembroke, at the head of one of the branches of the great "drowned" harbour of Milford Haven, has been used as a naval dockyard.

South-east Wales.—The eastern part of South Wales differs markedly from the west because the penneplain has been raised to a plateau which bears productive Coal Measures. The northern margin of the plateau, however, is much like Central Wales, for it consists of the high, bleak scarp of Old Red

sandstone, which has little economic value ; consequently this almost mountainous area shows more general similarity to the country north of the Wye valley, which it overlooks, than to the industrialized coal-mining area to the south. This composite tract of South-east Wales is therefore taken to consist of the coalfield and the adjacent coastal plains which are closely associated with it, the boundary of this relatively densely populated area being drawn along the northern outcrop of the Coal Measures. The now insignificant coal area of Pembroke-shire is excluded from this region.

A useful key to the geography of the *South Wales Coalfield* may be found in the hydrography, i.e. the arrangement and character of the river valleys, of which there are three main groups. In the east, the plateau is dissected by several deeply incised valleys, scoured by glacial action to a U-shaped section, some having their rise near the scarp of the Brecon Beacons and all cutting across the coalfield with more or less parallel courses in a general north-west to south-east direction ; in their lower parts the rivers nearest the boundary of the coalfield turn eastward and join to enter the Usk near Newport, while the others, as far west as the Taff and the Rhondda, enter the Bristol Channel at or near Cardiff.

A central group of shorter streams rising in the middle of the coalfield flow southward and join to form the Ogmore, which enters the sea after passing Bridgend.

The third group of rivers drains the western side of the high plateau ; they flow in a general south-westerly direction, and include the Neath which passes the town of the same name before reaching Swansea Bay, the Tawe at whose mouth stands Swansea, and the Loughor which enters Burry Inlet near Llanelly.

The deep valleys, particularly those in the east, have been very important in the development of the coalfield, for galleries were driven from the sides into the upper seams and pits sunk into the bottoms to reach the lower seams ; further, the valleys have offered opportunities for roads, canals and railways to run down easily to the ports near their mouths.

The quality and form of the seams of coal have also been of vital significance. The great earth movements, which bent the strata into the basin-like form, have fractured them and produced many faults. These interrupt the working of the coal along the

seams, thus adding to the difficulty and cost of mining, but the pressures and accompanying heat have had a compensatory effect in carbonizing the original vegetable matter of the coal to an extraordinary degree, and so producing valuable fuel, burning with great heat and little smoke.

The ordinary bituminous coal, suitable for domestic use or for making gas, is found chiefly in a belt on the south-eastern margin. The central part of the field, extending diagonally from the north-east portion around Ebbw Vale and Merthyr Tydfil past the Rhondda valleys to the Ogmore area, yields steam coal,

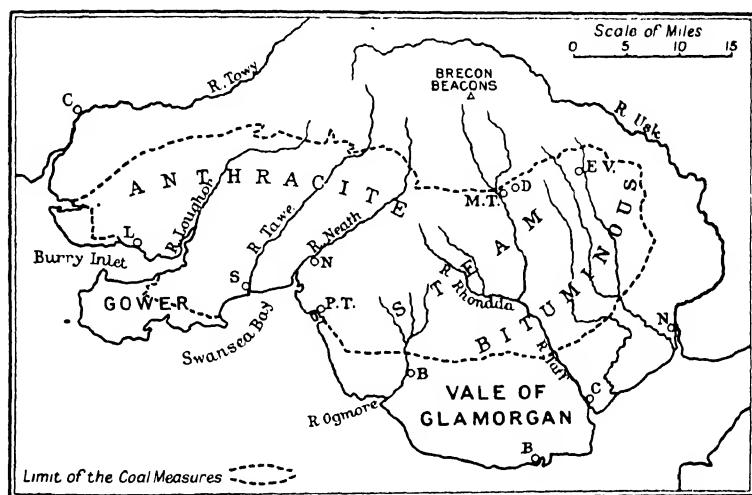


FIG. 43.—SKETCH-MAP OF SOUTH WALES COALFIELD.

largely smokeless and therefore particularly serviceable for naval and mercantile marine use, and in the north-eastern part also good coking coal. The north-western margin of the coalfield yields anthracite, burning with intense heat and specially useful for industrial purposes.

The different developments and changing fortunes of the three groups of river valleys have depended largely upon the contrasted characters of the coal. The north-eastern area was early exploited to utilize the iron-ore which occurred in the Coal Measures of this part, the fuel being charcoal from the forests then growing in the valleys. Later, the charcoal was replaced by coke from the coals of this region, and Merthyr Tydfil,

Dowlais and Ebbw Vale became important mining as well as iron- and steel-producing centres. The coal-mining spread down the valleys ; lines of villages and towns were crowded into their narrow spaces ; works and pit-banks intermingled with the houses, and the atmosphere became polluted by smoke. Under these anti-social conditions the valleys enclosed a dense population almost limited to the miners and their families, communication with the outside world being very limited.

By the coast large ports grew up, viz. Cardiff and Newport, and, later, Barry, which had the advantage of not being in a shallow river mouth. These ports at first exported coal, iron and steel, for the downward slope of the valleys facilitated movement of the minerals and metals to them, but when the local iron-ores were first supplemented and then superseded by foreign ores, mainly from Spain, these were imported through Cardiff and Newport. It therefore became economical to send the coal to the neighbourhood of the ports for smelting, and blast furnaces were set up at Cardiff ; still later, pig-iron and steel in the form of bars were imported to be worked up in steel works situated near both ports.

Meanwhile, the northern towns found their furnaces shut down, and also the best coal of the northern margin became exhausted and the mining tended to migrate down the valleys. This decline of the upper part of the coalfield was accelerated by the post-war depression so marked in the coal, iron and steel industries, and all the eastern section of the coalfield has suffered, the northern part probably doomed to extinction as a populated area.

An additional factor in the condition of the South Wales coalfield is the change-over from the use of coal to the use of oil in marine engines, and the large part of the field producing steam-coal has therefore lost much of the market on which it depended. The Rhondda valleys have been specially afflicted, and consequently the trade of the ports Barry and Cardiff, through which the steam-coal was exported, has decreased. Yet the work of the ports is more varied than that of the exclusively mining, or iron-working and mining, valley settlements, and hence their activity and the number of their inhabitants have been less reduced ; Cardiff still has a population of about 200,000 persons.

The central and western sections of the coalfield have had

a different development. The mines of the central area, the Ogmore group of valleys, were developed later than those of the east, and produced varied types of coal, the bituminous kind which is used for household purposes and has been in fairly steady demand, the steam-coal used for naval purposes and for which the market has declined, and special kinds employed in the relatively prosperous steel and tin-plate industries which have grown up in the western section of the coalfield. Consequently, the central mining area has not suffered so much as the east.

In the western area, draining to Swansea Bay and Burry Inlet, a distinction must again be made between the northern margin and the sea-board portion. The former is the anthracite mining area, the chief centres being in the upper parts of the valleys of the Neath, the Tawe and the Loughor. Almost all the anthracite is exported, being sent out from Swansea, Llanelly and Port Talbot. Anthracite contrasts with the other forms of coal in having suffered no decline, for its use in manufacturing is extending, and it is almost a monopoly of South Wales, the only other important producing region being in Pennsylvania, U.S.A.

The sea-board portion of the western coalfield yields bituminous and steam-coals and, like the eastern areas, has encountered a great reduction in its mining. Fortunately for the region, however, another development has occurred, and now its main resource is the tin-plate industry. The essential processes are the production of very thin sheets of steel, and their coating with tin, or with a mixture of tin and lead, or with zinc.

The industry began when tin was obtained from Cornwall, with short and cheap water-transport, but its supplies now come from abroad ; it utilizes as raw material steel bars either made in South Wales steel-works or, to a large extent in recent years, imported from abroad ; it uses as fuel either anthracite from the north, or coal mainly from the Ogmore valley region ; it requires large amounts of water from rivers ; finally, it exports most of its production. From these facts it will be seen that the coastal belt, and particularly the exits from the river valleys, afford the best sites for the works ; they are grouped mainly near the mouth of the Neath at and below that town, in the lower part of the Tawe valley above Swansea, and near Llanelly, with a smaller group at Port Talbot.

Zinc-coated or "galvanized" sheets are exported in large amount, "tins" are increasingly demanded for many forms of canning at home and abroad, and the uncoated steel sheets and those coated with the mixture of tin and lead are used for the motor-car industries of the English Midlands. With these markets, the tin-plate industry has developed, and has served to maintain a region which would otherwise have declined, for the other branches of metallurgy which previously flourished near Swansea have, since the war, been greatly reduced. Of the copper, zinc, lead, nickel and cobalt works, and refineries for silver and gold, few have been able to maintain themselves in face of competition elsewhere; now there are works only for utilizing copper and zinc, with sulphuric acid as a by-product of the zinc, in connexion with the tin-plate processes.

An independent industry is the refining of oil, which is imported at the Swansea docks and refined a few miles from the town, some of the products being re-exported from the same docks. Swansea is also a landing-place for fish, and with these varied forms of trade and with its marketing activities for a busy region, it is increasing in importance.

Apart from the industries and trade, the coastal belt of South-east Wales is a productive agricultural area. The Gower Peninsula, and especially the Vale of Glamorgan, are floored with fertile soils, and the small farms and market gardens send their produce to the neighbouring towns and mining villages.

The Population of the Welsh Peninsula.—Attention should be directed to the distinction between the political area of the Principality of Wales and the geographical region of the Welsh Peninsula as shown on the map in Fig. 40. The boundary between the Welsh Peninsula and the English Lowland is drawn where the upland affording only rough grazing gives place to agriculture. The coalfield of the south has been included in the Welsh Peninsula, although its eastern portion is in the county of Monmouth, for most purposes treated as part of England. Both the Peninsula and the Principality have a total area of approximately 7,500 square miles. As to the population, that of the Principality is about 2,150,000, but that of the Peninsula amounts to about 2,500,000 because it includes the whole of the densely peopled coalfield.

As shown on the regional map, the South Wales coalfield and the adjoining coastal lowland cover about 1,000 square miles

and have a population of approximately 1,575,000, i.e. an average density of population of 1,575 persons per square mile. The remaining part of the Welsh Peninsula therefore occupies about 6,500 square miles, but supports only 925,000 people; it is therefore relatively scantily populated, with an average density of population of about 140 persons per square mile.

For a period, a decline in the numbers of the people in the north and centre of Wales was off-set by the growth of the mining and industries of the south, but here, too, a decrease has shown itself, and the population of the whole of the Peninsula is becoming less.

When the distribution of this population is considered, the preponderance of the coalfield region is the most striking feature. Apart from this, it is noteworthy that the people are settled along the coasts and in the valleys; they look outwards, as it were, from the centre of the country either towards the waters of the Irish Sea and Bristol Channel or down the eastward-facing valleys to the English Lowland. For those in the valleys, communication across the uplands to other valleys is very difficult; only those along the coastal lowlands can get into touch with one another at all easily, but even here the fairly densely peopled north coast can be reached from the still more populous south only by a long and circuitous journey. The population is thus to a certain extent scattered, and definitely marginal; there is no natural centre of Welsh life. It is scarcely too much to say that isolation, to a greater or less degree, is even now a significant characteristic of the environment of many of the Welsh people, and in the past, with the lack of railways and even of good roads, without postal, telegraphic, telephonic and wireless means of communication, isolation was a very important factor in the lives of the people.

This segregation is one reason for the survival of the Welsh language, which is still spoken by some of the people everywhere except in the eastward-looking valleys and near the southern coasts; over most of the central and northern parts of Wales, at least one-third of the people can speak Welsh. With the language, Welsh traditions and characteristics have remained, and the annual "Eisteddfod" gathering, to hear and compete in poetry, singing and instrumental music, both expresses and intensifies a national consciousness.

On the other hand, because the Welsh people have been

separated by physical conditions and have had no natural centre in which a relatively large population can grow up and withstand foreign influences, they have been unable to maintain an independent political system; many centuries ago Wales and England were united under one government.

The lack of a national centre of Welsh life is illustrated by the fact that the University of Wales is not situated at one place but is formed of four constituent colleges; two are on the seaboard of Central and Northern Wales, the earliest founded being at Aberystwyth where also is the National library, and the other being at Bangor, while the remaining two are in South Wales at the largest centres of population, Cardiff and Swansea.

The Welsh language is one of the Celtic languages of the western parts of the British Isles, but how it is related to the others must be left for treatment in the last chapter of this book, together with a consideration of the bodily characteristics and the racial origins of the people of Wales.

The Devonian Peninsula.—*Relief and Structure.*—This tract-group includes the western parts of Somerset and Devon, which are marked off from the English Lowland by their greater heights and their older rock-formations, together with the whole of Cornwall; with it may also be included the Scilly Isles which lie about 25 miles south-west of Land's End.

In spite of the fact that the Peninsula stretches out to the south-west, it forms a part of the Armorican-fold system with west-to-east trends in the structure. The shape of the region is due in the main to the subsidences of areas situated to the south-east and north-west and their invasion by the waters of the English and Bristol Channels.

The geological map shows the rocks to be of the same age, and to bear the same names, as others previously described, but actually their composition is different in several respects. The "Devonian" rocks of North Devon and West Somerset are composed of resistant red sandstones and grits and greyish slates, while those of South Devon and Cornwall are largely slates of various colours with some limestones and sheets of volcanic material; the term "Old Red Sandstone" is therefore inappropriate to the rocks of this area.

In the more central parts of the Peninsula occur strata of the same age as the "Millstone grit," but they are here mainly composed of shales with bands of chert, limestone and impure

coal known locally as "culm," from which the whole succession is sometimes called "Culm Measures."

Thrust up in the south of the Peninsula are great masses of resistant igneous rock, mainly granite, while in the extreme southern points of Devon and Cornwall appear fragments of other igneous and metamorphic rock. After the Armorican folding and the subsequent wearing to a peneplain, the igneous areas remained above the general level, and still form broad, rounded uplands dominating the surrounding country.

These include Dartmoor, with its granitic, steep-sided "tors" rising to over 2,000 feet and surmounting the generally rolling upland. The edges are deeply cut by the streams falling to the valleys of the small rivers of Devon, and to the larger Tamar which forms the boundary between Devon and Cornwall.

Somewhat similar in appearance are the lower granite areas of Cornwall: Bodmin Moor reaching over 1,000 feet and the lower Hensbarrow "Downs" on the other side of Bodmin; the still lower moor between Falmouth, Camborne and Redruth; and the peninsula forming Land's End. The Scilly Isles are formed of the tops of a similar, but submerged, granitic mass.

It will be noticed that the heights decrease from north-east to south-west, and this is a general characteristic of the Peninsula dependent upon the uplifts which raised the peneplain to plateau-form. Because of the greater uplift in the north-east, the resistant grits and slates of North Devon form the broad mass of Exmoor where Dunkery Beacon, rising only slightly above the upland, reaches 1,700 feet, while the Culm Measures of central Devon form undulating country of moderate height, and south Devon and Cornwall, apart from the granite uplands, are mainly a low plateau.

The heather-clad uplands have attractive scenery, but otherwise the beauty of Devon and Cornwall lies mainly in the coasts. Where the more resistant rocks reach the sea they form bold cliffs or headlands, as on the northern edge of Exmoor, Bolt Head in the metamorphic mass of the southern tip of Devon, the granitic Land's End, and Lizard Point, formed of serpentine, at the extremity of Cornwall. As a striking contrast, there are deep indentations in the shore-line; in addition to the broad bays due to particular areas of subsidence, a slight general sinking has turned the lower parts of the river valleys into "rias," often branching and leading to deep, sheltered harbours, e.g.

those of Plymouth, Fowey and Falmouth. Everywhere the powerful waves of Atlantic storms have fretted the shores, forming steep cliffs, cutting off fragments to form tiny rocky islets and carving innumerable little bays and coves.

Climate and Vegetation.—Although there is no abrupt change in climatic conditions to be observed as one travels from eastern and central England to this south-western extremity, it is, nevertheless, clear that here a difference does exist. This is to be seen particularly along the southern coast of Cornwall, where almost sub-tropical plants may be grown, for the most striking characteristic of the climate is the mildness of the winter. The isothermal maps in the atlas show that at sea-level the mean temperature is about 44° Fahr. in January, while that in July is between 60° and 62° Fahr. The contrast with the conditions in eastern England is well shown by the graphs of temperatures for Falmouth and London respectively given in Fig. 15. At Falmouth even the mean minimum temperatures normally descend little below 40° in winter, and the extreme minima reach only slightly below freezing-point—very different records from those for London. The rarity of snowfall in the west should also be observed from the numbers at the bottom of the graphs. The causes of the mildness of the winter are the prevalence of the oceanic winds and the surrounding areas of water warmed by the Gulf Stream Drift from tropical latitudes.

The moderating influence of the water masses is well brought out by the run of the January isotherm of 42° which bends northward along each side of the Irish Sea, showing that the Devonian Peninsula, the Pembroke Peninsula of South Wales, and even parts of the Lley Peninsula and Anglesey in North Wales, have a mean temperature above 42° in January, i.e. above the limit of growth for wheat and near that for the beech. Consequently, here in the south-west some forms of vegetation can grow throughout the winter, though very slowly, which in most of England must have a rest-period during that season, while others can begin growth and other life processes, such as flowering and ripening, much earlier in the year in these regions with mild winters. The longer hours of sunshine in the spring (shown on the graph for Falmouth as contrasted with that for London) is another factor assisting earlier development of vegetation.

On the other hand, the isothermal map for July and the

summer portion of the temperature graphs show that the water-masses modify the heating influence of the sun in summer, and neither the mean nor the extreme temperatures are then as high as in the south-east of England. Moreover, the rainfall is at all periods higher in the west than the east (see the rainfall maps and graphs); this aids rather than hinders the early growth of most plants, but the heavier rain in summer in the west may

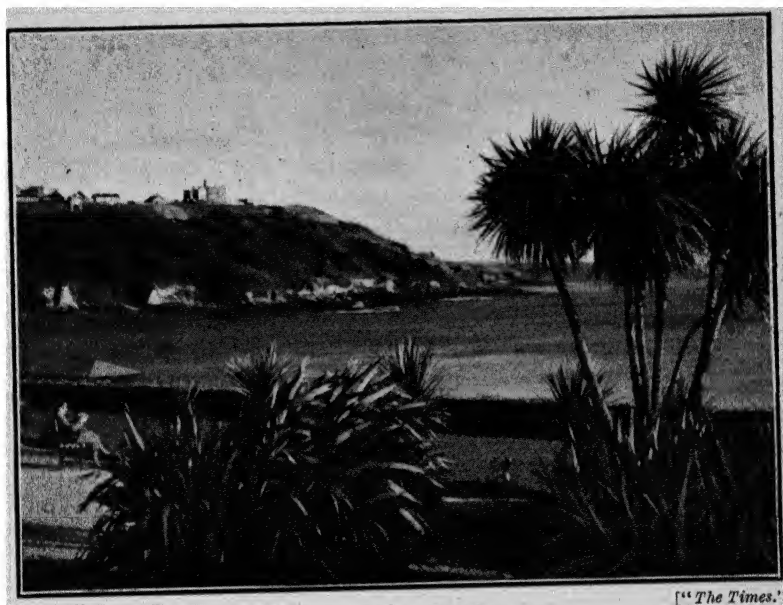


FIG. 44.—THE CORNISH COAST BY FALMOUTH.

The view shows that the coast is a low plateau cut by the sea. On the promontory is an old castle built to defend the inlet; in the foreground are new gardens, with "semi-tropical" plants, laid out for the enjoyment of visitors.

join with the lower temperatures to retard or prevent ripening of such plants as cereals.

Consequently plant life in general shows different characters in the peninsular and insular regions of South-western Britain as compared with the more "continental" regions of the English Lowland.

The cooler and rather humid uplands frequently bear peaty moors with mosses and cotton grass, the better-drained parts being heaths with whortleberries and gorse among the heather, while the valley slopes and lower lands may be woodlands in which grow, not only the common trees of southern England, but

also those introduced from warmer lands, such as great walnut trees, and the smaller arbutus, rhododendrons and laurels.

Economic Activities.—The farming also responds to the climatic conditions. While there is only rough pasture for sheep and cattle on the uplands, the lowlands are largely permanent grasslands of considerable value, for the mild winter and abundant moisture favour the growth of grass almost throughout the year, and even in winter stock can feed in the fields and do not need stall-feeding upon imported food-stuffs. Large numbers of store cattle are raised, and in the valleys dairy cattle are kept for the production of milk, butter, cream and cheese. The arable land, of which there is a fairly large proportion in Cornwall, is mainly given up to obtaining fodder; for this purpose a mixed crop of oats and barley is commonly grown.

The influence of the mildness of the winter, the early warmth of spring and the absence of spring frosts¹ is still more strikingly shown in the cultivation of early vegetables, such as broccoli and potatoes, which are grown in the extreme south for the metropolitan market; the high price obtained during the short time in which these are regarded as luxuries more than repays the cost of transport over such a long distance. For similar reasons there is considerable cultivation of flowers and bulbs along the sheltered coast of southern Cornwall and on the Scilly Islands.

The maritime characteristics of the region are still more directly shown by the fishing industry; there are some relatively large centres including Plymouth, to which trawlers bring the catch from distant grounds, and many small coastal towns and fishing villages in the sheltered bays have their own group of boats. In recent years, the in-shore fishing has declined seriously because the fish are taken from the off-shore grounds by trawling fleets which come from other coasts. Consequently the fishing settlements have suffered, and it is fortunate that they have had a supplementary resource in the tourist industry. In many cases this has become of more value than the fishing, and has led to the growth of towns of some size.

¹ In connexion with frosts which might endanger the young potatoes, we may note the significance of the *extreme minima*; these might indicate occasional disastrous frosts, but as shown in the graph for Falmouth they do not here descend below freezing-point in spring.

The great drowned harbour of Plymouth Sound was selected as the site of a naval dockyard because of its sheltered and defensible position at the entry to the English Channel, and round it has grown up the conurbation of Plymouth, Devonport and Stonehouse, with a population of about 200,000 people, the only large settlement in the Peninsula. Plymouth is the commercial "capital" of the region, a convenient market and centre of communications for all parts except the north, but it has only local importance. It has not developed into a great port, in spite of good harbourage and its position adjoining important maritime trade-routes, because of the cost of the long transport by land to the main areas of population and production in Britain; but mails and passengers requiring rapid transit are landed from liners which call at Plymouth for that purpose.

The drowned valley which opens into Falmouth Harbour has allowed the sea to penetrate half-way across the Cornish portion of the Peninsula, and at its head the county town of Truro has grown up.

In the past, the minerals which owed their existence to the geological structure played a part in attracting traders to this part of the British Isles and aided in supporting its population; tin occurred in association with the granite outcrops, particularly near Redruth and Camborne, and in the same district copper was obtained, but the competition of more easily worked deposits has caused the abandonment of all but a few tin mines. Granite and slate are quarried in several parts, but the chief mineral production is that of china-clay, or kaolin, which occurs as the result of changes in the granite, and is now obtained mainly from the igneous mass south-west of Bodmin in Cornwall, and shipped from Fowey and Par; somewhat similar clays are quarried on the eastern edge of Dartmoor.

The area of the region here marked out as the Devonian Peninsula is about 3,500 square miles, and it supports a population of about 850,000 people. Hence, the average density of population is about 240 persons to the square mile; this figure is higher than that for Wales (excluding the coalfield), as one might expect bearing in mind that the Devonian Peninsula has a larger proportion of lowland and a climate rather more favourable to agricultural production, but it is considerably lower than that for the English Lowland, and as in Wales the number of the inhabitants is decreasing.

In these two important facts regarding the population, viz. the low density and the decrease of the total number, the Devonian Peninsula shows its closer affinity to the Welsh Peninsula and the other regions of the west and north of the British Isles than to the English Lowland.

Indeed, while the two peninsulas considered in this chapter are closely related in character and situation, they are separated from the rest of Britain either by their characteristics or by their situation; consequently they may be regarded as constituting a distinct sub-region.

The Channel Islands.—Geographically, this group of small islands, including Jersey, Guernsey, Alderney and Sark, forms part of North-western France, and as this region is closely related to the Devonian Peninsula, these islands may be briefly considered at this point. In many ways they are similar to southern Cornwall—in their structure and their relief, with their rocky, wave-cut coasts, in their mild climate, and in their production of flowers and early vegetables for the London market. The breeds of cattle named after the largest islands yield milk from which butter is made and exported. The extraordinarily intensive cultivation makes possible a remarkable density of population, and on a total area of only 75 square miles there are supported nearly 100,000 persons.

The islands are “British,” inasmuch as they were portions of the ancient Dukedom of Normandy and have remained under the British Crown, though they have their own laws and customs. While the English language is everywhere used, many of the islanders speak French or a Norman dialect.

CHAPTER XII

THE CENTRAL UPLANDS OF BRITAIN

THE more northerly parts of Great Britain will now be considered.

The Pennines are connected by high saddles with the mountains of the Lake District to the west, and to the north they are separated only by a narrow trough, the "Tyne Corridor," from the Cheviot Hills, which in turn merge on their western side into the Southern Uplands of Scotland. To these four upland areas, with their valleys and associated coastal lowlands, one comprehensive name, the Central Uplands of Britain, may be given. It is noticeable that over most of these uplands the term "fells" is applied to outstanding heights, while the valleys are known as the "dales."

Between the Southern Uplands of Scotland and the Lake District, a local subsidence of the Earth's crust has led to the formation of the Solway Firth and has broken the continuity of the uplands by the Solway Lowland. This area is so closely related to the surrounding uplands that it must be treated as a portion of the general Central Uplands region although it has exceptional characteristics in several respects; it naturally resembles the dales which lead down into it from all sides rather than the uplands proper.

The political separation of England and Scotland tends to hinder the appreciation of the geographical facts of the region, for the frontier does not follow natural boundaries; on the contrary, the political frontier artificially bisects the geographical unit of the Solway Lowland, cuts off a fragment of the Cheviot Hills from the rest, and by following the lower course of the Tweed river divides the Tweed valley. Scotland is, indeed, separated from England by historical traditions and associations rather than by present-day geographical conditions.

Owing to the political separation there is a slight difficulty in nomenclature, for the term "Southern Uplands" is quite

suitable while this region is considered as part of Scotland, but when the Central Uplands of Britain are treated as a unit it may seem inappropriate to refer to their northernmost portion as the Southern Uplands. To avoid this difficulty the term "Scottish Uplands" will here be employed, and this usage may also serve to emphasize the distinction between this region and the "Scottish Highlands" which are situated beyond the Central Lowlands of Scotland.

The Pennine Upland.—Three tracts are clearly distinguishable within the Pennines: a southern one extending as far north as the Aire valley, a central one from there to the Stainmore Pass and a northern one to the Tyne Corridor.

The Southern Pennines.—The geological section and map (Figs. 32 and 34) show that the southernmost part is an anticline, of Hercynian date, on which the denudation of the Coal Measures has exposed in the central upland area Millstone grit and Mountain limestone. Although the valleys were occupied by ice and have morainic deposits, most of the higher areas were not glaciated, and the soils and scenery therefore exhibit characteristics directly dependent upon the rock structure.

The limestone plateau areas resemble the similarly formed Mendip Hills; they have a generally level, dry surface on which but a thin soil has developed giving a natural but not rich grassland, or "dry moors" with bilberries and heather. Occasionally, where the rock is particularly porous, and vertical joints increase the rapid disappearance of rain-water, the ground is practically bare of vegetation and has Karst-like characters. Here there are swallow holes, where streams plunge underground, and flow through tunnels and caverns to emerge in cañon-like valleys; in these there is frequently a richer vegetation of grasses, herbaceous plants and some trees, especially ash. Where shales occur within the limestones, wider valleys have been eroded, where cattle, kept for dairying, find better pastures than on the plateau; in these wider valleys are the villages and the routes through the uplands. Faulting has allowed mineralized water to be forced up from the depths, and the warm springs have given rise to the health resorts of Matlock Bath and Buxton.

The grit areas are very different, and more resemble the central Welsh Uplands; they form plateaus with deeper soils

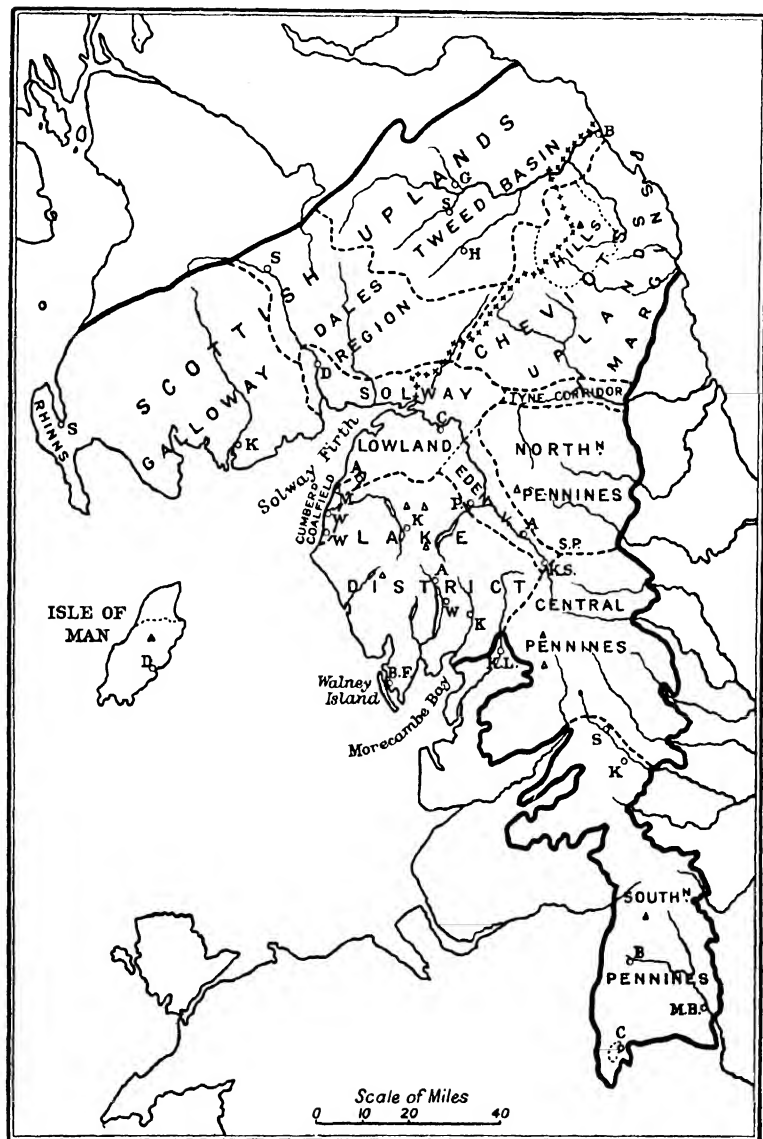


FIG. 45.—REGIONS OF THE CENTRAL UPLANDS OF BRITAIN.

Note.—The geological structure of this region is shown in Figs. 32 and 51.

than those of the limestone country, frequently ill-drained and sometimes becoming "wet moors" with cotton-grass and peat. The surface streams have eroded the strata so that their edges form steep scarps and ridges; the upland scenery is more striking and less monotonous than that of the limestone areas. The "Peak," which rises to over 2,000 feet, is ill-named, for it is a great, almost horizontal mass of grit-stone lying upon the limestone plateau, carved into wild shapes and with a precipitous western edge known as Kinder Scout (see Fig. 34).

By means of the dairy farming of the valleys, the poorer pasturage of the plateau, the tourist industry, quarrying and some mining of lead, barytes and fluor-spar, the Southern Pennines support a very small population. An exception occurs in their northern portion, where the valleys afford communication between the industrial regions of either flank. Of these valleys that of the Aire is the most important; where side-streams enter it are the small woollen manufacturing towns of Skipton and Keighley.

The Central Pennines.—The Aire gap is the most important of several known as the Craven gaps, from the name of this district of Yorkshire; they have been worn down in a region where the rock structure has been weakened by the Craven series of faults. North of the Aire gap the structure of the Pennines is no longer anticlinal; the region is rather an immense sheet of limestones and sandstones dipping eastward from a high western area in which Wharfedale and Ingleborough reach about 2,400 feet. The rather indefinite boundary between the Pennines and the Lake District is formed by another series of faults running from about Kirkby Lonsdale on the Lune to Kirkby Stephen at the head of the Eden valley. A third series of faults is responsible for the hollow of the Stainmore Pass, which affords a route through the upland between the Central and Northern Pennines. The central block is itself made accessible by the valleys of the tributaries of the Ouse: Swaledale; Wensleydale, the valley of the Ure; Nidderdale; Wharfedale. The scanty population lives in scattered farms and small villages in the dales; between these are the broad moors above which a number of "fells" rise to over 2,000 feet.

The Northern Pennines.—This region has a still greater average elevation, and the block overlooks the Eden valley on the west from heights culminating in Cross Fell at almost 3,000 feet

(see Fig. 35). This edge, formed by the "Pennine Faults" which have let down the Eden valley, is one of the most striking features of northern England; from it a high plateau extends eastward for many miles with only a slight dip and relatively little dissection.

The population of the dales becomes still less in the more northerly tracts of the Pennines; together with some quarrying and a little mining like that of the Southern Pennines, pastoral work is the main resource and the keeping of sheep becomes more important than the rearing of cattle.

The Tyne Corridor.—Still more faults, associated with a synclinal bending of the strata, have produced the Tyne Corridor, an inter-regional stow which marks the end of the Pennines. It is economically important in giving easy communication, at a height of less than 600 feet, between north-eastern and north-western England. To guard the Roman line of communication and to protect Roman Britain from attacks of the "Picts and Scots," Hadrian built his wall along the northern side of the corridor.

Cultivated lands, mainly under permanent grass, extend through the whole corridor; there are a number of villages, and two small towns have grown up where the north and south branches of the Tyne enter the main valley.

The Cheviot Upland.—North of the Tyne Corridor rises the Cheviot Upland, which culminates in the granitic mass of "The Cheviot" at about 2,700 feet, surrounded by a belt of volcanic and other igneous rock to which the term "Cheviot Hills" may most properly be restricted. This nucleus (shown on the geological maps) has smooth and rounded heights, and its crystalline rock weathers to a soil covered with turf. Though in winter it is frequently snow-covered, in summer it is a relatively rich grazing ground for great numbers of sheep.

Around this central mass is an area which may be called the Cheviot Uplands; it is high in the west but dips considerably to the east. Although shown on geological maps as consisting of the Carboniferous limestone series, it is actually formed largely of sandstones; the most suitable common description of the lower Carboniferous rocks here and in Scotland is perhaps "calciferous sandstone." The Cheviot Uplands have often a covering of boulder clay, and are largely impermeable, with poor drainage; consequently they form a rough moorland with

patches of peat moss and stretches of heather and are of less economic value than the igneous Cheviot nucleus.

A much more productive part of the tract is, however, the series of valleys which have been cut into the sandstone area, and fall into two groups : (i) the south-flowing tributary valleys of the Tyne ; (ii) a wider and almost continuous band near the eastern edge of the nucleus, formed by the upper valleys of the Aln and Coquet, and the valley of the northward flowing Till tributary of the Tweed.

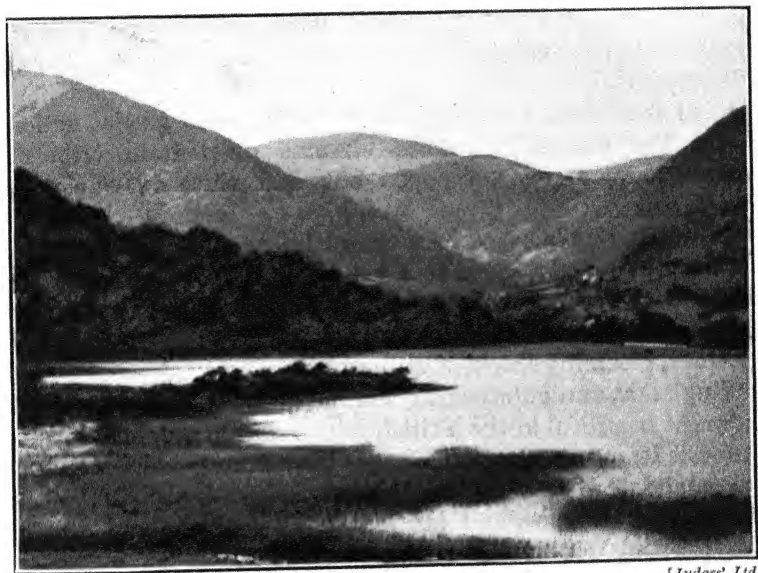
Finally there are the low Cheviot margins which border the Northumberland coalfield on the south-east and form the narrow coastal plain between the Coquet and the Tweed. The farming centres are situated in these Cheviot margins and in the adjoining valleys. There is a little arable land, but permanent pasture covers nearly the whole of these glaciated lowlands. The land is devoted mainly to the keeping of sheep, the chief aim of the work being the production of lamb and mutton rather than of wool.

The Lake District.—This may be described as a mountainous region, almost circular in general outline, and deeply dissected by streams radiating from the centre ; in many of the valleys are long narrow lakes to which the name and much of the attraction of the district are due. To the mountains of Westmorland and Cumberland, the name “Cumbrian” is often given.

From the point of view of structure the region may be regarded as a great dome of igneous and metamorphic rocks, once covered by a cap of younger sedimentary material. From the central part of the dome consequent streams ran down in various directions and thus determined the situation of the present valleys. In course of time the central area was denuded of the sedimentary strata, which now remain only on the flanks ; for example, an almost complete ring of Carboniferous rocks (including Coal Measures on the north-western slopes), New Red layers along the south-western coast, and Permian and New Red sandstones in the Carlisle lowland and the Eden valley.

In the central area the ancient rocks fall into three main groups which may be named after striking physical features in their respective neighbourhoods : in the north the “Skiddaw” slates, in the centre the “Borrowdale” volcanic series and in the south the “Windermere” shales and sandstones. The streams have maintained their original courses across the out-

crops of the various rocks, and are therefore "superimposed" upon the present surface, but the scenery varies according to the rock structures. The central volcanic rocks contain hard masses alternating with looser ash-material, and in consequence the relief of the surface is very irregular and the heights often have sharp "pikes" and precipitous, narrow "edges," while on the slopes huge screes are formed. Here Seafell Pike rises to 3,200 feet, the greatest elevation in England, and Helvellyn, with its



[Judges' Ltd.]

FIG. 46.—HEAD OF ULLSWATER IN THE LAKE DISTRICT.

In the foreground water-plants prepare the way for an extension of the land, and on the farther side of the lake is a small delta. Woods and small settlements are to be seen by the lake side and in the adjoining valleys, but the mountains in the background, rising towards Helvellyn, have a scanty vegetation cover.

famous "Striding Edge," is but little lower; "The Scree" cover the steep slopes of the mountain mass above Wastwater. The northern area of slates has in general more rounded contours; in this section are Skiddaw and Saddleback at about 3,000 feet. The southern part, formed of shales, slates and sandstones, has lower and less striking, but still beautiful, scenery.

Glaciation has been an important factor in shaping the features of the region. On the great central heights, an ice-cap

accumulated and glaciers worked down the flanks, in some parts scouring and deepening the valleys and in other parts blocking them up with morainic material. With such interruptions to the normal profile of valleys, post-glacial streams filled long stretches with water and lakes radiate in all directions. The largest lake to-day is Windermere, 10 miles in length, but originally the lakes were much longer, for they are being filled in with alluvium deposited by the rapid streams fed by abundant rains. The valley of Borrowdale now ends in Derwentwater, but this lake was once continuous with Bassenthwaite ; between the two lakes the valley bottom is covered with the deposit from side-streams.

High mountain tarns owe their existence to glacial action ; so do the waterfalls, where streams drop from tributary valleys to main ones, scooped out and thus over-deepened by the ice.

As in North Wales, so here the mountains rise steeply above the deeply eroded valleys to a height of two or three thousand feet and the scenery has a grandeur surpassing that of many higher but less dissected regions. The alternation of rich valley pastures, gleaming sheets of water, scree-covered slopes, heather-clad uplands, and culminating summits makes the region one of the most beautiful in the British Isles. Large numbers of tourists visit it, and towns and villages have adapted themselves to accommodate them ; among the larger centres are Keswick on the edge of the lowland between Derwentwater and Bassenthwaite, and Windermere and Ambleside by Lake Windermere.

The Cumbrian Mountains, facing the south-westerly winds from the sea, have the greatest rainfall of England ; much of the central area has over 100 inches, and even on the flanks the precipitation is heavy. With such conditions of relief and climate and a cover of boulder clay upon all the gentler slopes and the lowlands, agriculture in this region is very limited. The high mountains and moorlands are beautiful but of little economic value ; the lower slopes give rough grazing for sheep in summer ; in the dales is better pasture for sheep and cattle, together with small patches of arable land on which oats are the main crop. In the central region sheep are the most important, but in the lower marginal areas, particularly in the south, dairy cattle are kept to supply the needs of the northern industrial regions.

The Cumbrian region has, moreover, mineral resources. There is quarrying for slates and road-metal in the central area, but the chief production is from the sedimentary rocks on the north-western and south-western flanks. The small *Cumberland Coalfield* extends from Whitehaven past Workington and Maryport to Aspatria; as in the case of the coalfield of the north-eastern coast, so here in this north-western one the mining extended out below the sea to a distance of about 4 miles.

Behind Whitehaven the Carboniferous limestone yields some hæmatite, an ore with an unusually high iron content. The coal and iron, with limestone and fireclay, occur in close proximity to each other and to harbours. Consequently a "West Coast" iron and steel industry grew up; the chief product was pig-iron, sent away for use in the steel industries of the manufacturing regions on other shores of the Irish Sea, viz. Belfast, the Clyde and South Wales, and also sent to Sheffield by rail. In recent years, however, the iron mining has greatly decreased and the iron and steel industry has declined.

Hæmatite iron-ore is found, too, in the Carboniferous limestone in the extreme south of the region, i.e. in the Furness district, a detached portion of the county of Lancashire. Here the ore has already been largely extracted and the present production is small. A shipbuilding industry developed at Barrow-in-Furness, where a harbour had to be dug from the shallows in the protected channel behind Walney Island. Barrow became the largest town of the region, but with the lessening in the local production of ore and the general decline in shipbuilding, the population is now decreasing.

At Kendal, a meeting-point of local routes, a small woollen industry has survived from past times when it was based on the local production of wool and was spread more widely over the region.

The Eden Valley.—Between the north-east flank of the dome of ancient rocks and the faulted edge of the Pennines, the Eden valley is a deep trough in which have been preserved red sandstones and marls, of Permian and Triassic age, much overlain by glacial deposits. The soils are generally fertile, and the valley, sheltered by the Cumbrian Mountains from the rain-bearing winds, has a drier climate and a larger proportion of arable land than the rest of the Lake District. Yet as in the other western lowlands, the greater part even of the arable land is given to

grasses ; oats and root-crops are also grown, but cattle rearing is the main aim of the farming.

Through the Eden valley runs the important " West Coast " route which crosses from Lancashire over the eastern flank of the Cumbrian Mountains by Shap Fell into the centre of the valley near Penrith, while less important routes which cross or skirt the Central Pennines enter the head of the valley and meet at Appleby, the county town of Westmorland.

The Solway Lowland.—The greater part of this region is underlain by sands and marls of New Red and Permian age, and although it has been glaciated, the main effect of the ice has been to wear away and redistribute the underlying material ; consequently the soils are sandy and loamy rather than clayey. By the innermost shores of the Firth considerable areas of alluvium have been formed, and extensive flats are exposed at low tide.

Two features of the landscape which are common and stand out markedly in this lowland region are due to the glaciation, viz. drumlins and eskers. Drumlins are low, oval-shaped hills, composed of masses of sandy, gravelly or clayey material accumulated beneath the ice-sheet ; they are usually grouped to form lines which are more or less parallel to each other. Eskers have a somewhat similar origin, but consist of long, winding ridges of gravel and sand, which may run across the country for great distances. Both forms of deposit are found in Northern England, but in Scotland and Ireland they attain greater prominence, and sometimes have a considerable influence on the human geography ; for example, the eskers may give dry sites for settlements and roads above low and marshy country, and the mixed soils of the drumlins may lead them to be used for arable land, and to stand like fertile islands in areas which otherwise yield little sustenance and have few inhabitants.

Most of the Solway Lowland, however, is a productive farming country, whose characteristics much resemble those of the Eden valley. There is, indeed, no definite boundary between these two regions, and similarly on the northern side the Solway Lowland merges into the broader dales of the Scottish Uplands ; it is convenient, however, to include in the coastal region the lowland of the Nith valley to above Dumfries. Although this is a small town, it is the largest in the south-west of Scotland ; it is in several respects the counterpart of Carlisle, which is similarly the largest city in the north-west corner of England. Dumfries

is a market-town, where coastal routes converge with one crossing the Scottish Uplands by Nithsdale, though the express trains between England and Scotland go through the more central Annandale. Carlisle has a more marked focal situation, for all the western and central routes through the Scottish Uplands must avoid the Firth and pass its site, while on the English side the roads from the south are met by the route from the east coast through the Tyne Corridor. It is obvious that the position of Carlisle accounts for its importance in the history of the relations between England and Scotland, and to-day, besides being an important railway junction, it has a small group of miscellaneous manufacturing industries.

The Scottish Uplands.—This region is of block structure, composed of early Palæozoic strata with the “Caledonian” trend from south-west to north-east. The rocks are largely grits and sandstones, with fairly uniform power of resistance to erosion and in consequence the region consists of a broad plateau lacking in sharp outlines; it is without very high peaks or ridges, and undulating contours are more characteristic than deeply cut valleys. It is bordered on the north by a series of faults which are shown on the geological map as an almost straight line running from near Girvan on the coast of Ayrshire to Dunbar on the coast of Haddington.

Some climatic differences between the western and eastern parts of the region may be observed. While summer temperatures do not vary greatly, except of course on account of differences in altitude, the west has a milder winter and consequently a rather longer growing period than the east. A more important contrast is in respect of rainfall: while in much of the west, and in the higher parts of the centre, there is a fairly high annual amount of about 60 inches or even more, the east has in general less than 40 inches, and near the east coast and in the lower Tweed valley the precipitation is below 30 inches per annum.

There are also certain variations in the structure of the Scottish Uplands which characterize the western, central and eastern portions respectively, and add to their climatic differences. We may therefore see marked contrasts between Galloway in the west and the Tweed Basin in the east, and regard them as separate tracts; between them is a central area, transitional in type, which may be termed the Dales tract since it includes

Nithsdale, Annandale and Liddisdale cut by the Nith, Annan and Liddel respectively.

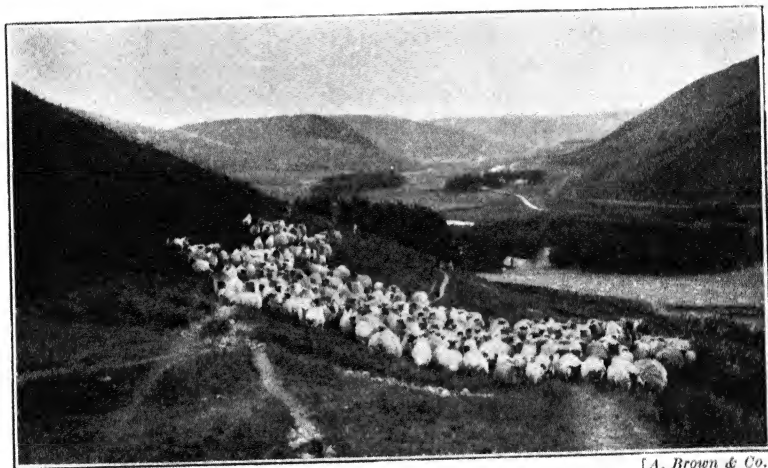
The Tweed Basin.—North of the Cheviot Upland there extends a broad area of the “Carboniferous limestone,” which is here composed largely of sandstones and shales, and west of this area is a wide belt of Old Red sandstone. These rocks, less resistant than the lower Palæozoic strata of most of the Scottish Uplands, have allowed the Tweed to wear down a wide lowland, the Merse, in the lower part of its course. Moreover, while in the west and centre of the Scottish Uplands the drainage is commonly transverse, the streams running across those regions from the north-west to the south-east, the upper part of the Tweed and some of its tributaries, such as the Ettrick and the Teviot, have developed longitudinal courses running from south-west to north-east. They have thereby formed a relatively large river-system giving to the Tweed basin a broad unity which is lacking in the western and central areas, where the dales are comparatively isolated from one another.

On the north side of the Tweed Basin, the upland has been reduced to a narrow belt including the Moorfoot and Lammermuir Hills, whose rounded forms overlook the Central Lowlands of Scotland and become lower where they reach the east coast in St. Abb’s Head ; on the west of the basin the land rises to higher and broader “fell” country.

Most of the upland is utilized, for it is covered with pasture consisting of grass and heather on which very large numbers of sheep are fed ; for its size, this is the most important sheep-rearing area of the British Isles. Woods have long since disappeared except in the valleys and lowlands, and even the wet moors have been transformed into valuable land by cutting drains to the streams. As the valleys widen out towards the lower country, arable land increases in amount, till in the Merse region a large proportion of the country is under the plough. Yet the raising and the feeding of sheep and, to a smaller extent, the breeding of store cattle, still dominate the farming, and the crops are mainly grown for the use of the animals ; grasses, roots and oats are the chief products, while barley is grown considerably to obtain malt for brewing.

In the valleys leading down from the uplands, the making of woollen goods early developed, based on resources similar to those of the early industry in the Pennine valleys, viz. the local

sheep-rearing, soft water from the grits and sandstones and water-power from the swift streams. When, however, coal was used for power the Pennine region had an advantage lacking in the Scottish Uplands, where the industry could meet competition only in the finest quality "tweed" goods. This development necessitated the use of finer wools, and therefore the rearing of Cheviot sheep on the Scottish hills, and also the import of foreign wool. The industry is now located mainly in the valleys above the Merse, at Galashiels, Selkirk and Hawick; at the last-mentioned town woollen hosiery is also



[A. Brown & Co.]

FIG. 47.—THE UPPER VALLEY OF THE TWEED.

The skylines show the region as a dissected plateau; the flat-bottomed valley has been drained and is utilized for sheep-pasture. There is rough pasture on the hillsides, and small woods form the only other vegetation cover of the land.

made. It will be observed that though geographical inertia has hitherto allowed the woollen industry to persist, there are now practically no advantages in its location to enable it to compete with that of other areas, particularly as this region has neither a local market nor a great port at hand; the woollen industry is therefore decreasing in importance.

Berwick, at the mouth of the Tweed, and the border town between England and Scotland on the East Coast route, is part of this region though politically in England. It has had a chequered history during the centuries; it was seized by the rival powers again and again, and its economic importance has likewise varied, its trade to-day being small.

Galloway.—In the western part of the Scottish Uplands, the geological map shows areas of igneous rock which are largely granite and have given rise to high moors of wilder aspect and greater height than elsewhere in Southern Scotland ; there is the Kells Range, and the neighbouring Merrick rises to nearly 2,800 feet. On the other hand, a tilt towards the south and the south-west of Galloway and a general depression of the plateau have allowed its lowest parts to be invaded by the sea. Consequently, around Wigtown Bay is a coastal lowland, and the submerged Lucc Bay and Loch Ryan almost meet and form the peninsula of the Rhinns of Galloway, joined to the mainland only by a low plain.

Because of its western situation, Galloway has a heavier rainfall than the Tweed Basin, and on its plateau areas are wide stretches of moor with peat-bogs ; its valleys and coastal lowlands are covered with glacial deposits with a large proportion of clay, the arable land being often situated on the gentle slopes of the drier eskers and drumlins. It is cattle country, as contrasted with sheep country, the animals being kept both for beef and for dairy purposes, producing milk and cheese ; pig-keeping is associated with the dairying industry. The cultivated areas are largely grass-lands or are sown with oats and root-crops. A recent economic development is the utilization of the Dee for hydro-electric power at a series of five stations a few miles above Kirkeudbright ; fed into the " Grid " system of transmission, the power is utilized as far away as the industrial areas of North-western England and Central Scotland.

The larger settlements of Galloway are merely market-towns, for the region lies west of the main lines of land communication ; however, on Loch Ryan is the ferry port of Stranraer, from which there is the shortest crossing between Great Britain and Ireland.

The Dales Region.—This part of the Scottish Uplands is the area cut into by the dales of the Nith, the Annan and the Liddel. In its physical characteristics this central area is intermediate between the wetter, cattle region of the west and the drier, sheep region of the east ; the work of the dale farms is correspondingly balanced. Nithsdale is exceptional among the Scottish Upland valleys, for it is relatively broad and low, its erosion having been facilitated by structural weakness. The geological map shows that in three parts of its course, younger

and less resistant rocks have been let down by faults below the general level of the uplands; thus they were preserved from denudation which removed the corresponding rocks on the more exposed, higher areas. One of these preserved masses is a basin of Coal Measures, situated in the upper part of the dale, which has given rise to the small coalfield of Sanquhar.

From the foregoing account it will be seen that the Scottish Uplands form a tract-group which over most of its area resembles the other parts of the Central Uplands of Britain in offering few opportunities of livelihood except that of farming in the valleys; only in part of the Tweed system of valleys is there any considerable population, and in that area, as elsewhere, migration to regions with more resources causes a decrease in the number of inhabitants.

Taking into account the similarities between the Scottish Uplands, the Cheviot Hills, the Lake District and the Pennines, and also the contrasts which mark them off from the English Lowland to the south and Central Scotland to the north, we may regard the Central Uplands of Britain as a sub-region. There are, of course, relatively small lowland areas included in this Central Uplands sub-region, as is practically always the case when the main and characteristic parts of a region are upland or highland.

The Isle of Man.—In the midst of the submerged area of the Irish Sea rises the Isle of Man, similar in some respects both to North Wales and to the Lake District. It may be regarded as an exclave of the Central Uplands of Britain. Except for the low, flat northern portion, it is a small upland formed mainly of slates of early Palæozoic age. These have had a complicated geological history and now rise to rounded heights, which in Snaefell exceed 2,000 feet. The upland is deeply dissected by streams and worn on the coasts to wave-cut, rugged cliffs. The northern plain is covered with glacial drift and bordered by wide, sandy flats.

The wind-swept uplands are clad with heather, low-growing gorse and rough pasture for sheep; in the south, farming settlements are restricted to the narrow valleys and patches of lowland by the coast, but on the northern plain agriculture like that of the Solway Lowland is more widely carried on. Quarrying for slates and building stones gives occupation to a

small number of people ; a larger number get their living from fishing, and, as in the Devonian and Welsh peninsulas, the fishing villages and small towns have grown considerably with the tourist industry of recent years. But, again as in the case of the western regions of England and Wales, this has not compensated for the decline of other means of livelihood, and the small population of less than 50,000 people is decreasing.

The largest town is Douglas, the port of entry for passengers and trade from Great Britain ; it is the "capital" of the island, which has a separate government for many purposes, with its "House of Keys" corresponding to the British "House of Commons." This semi-independence in political matters has been made possible by the insular position, which is also a reason for the survival of Manx, a Celtic language akin to the Gaelic of North-western Scotland and Ireland ; very few people, however, can now understand Manx, and English is everywhere the speech of the islanders.

CHAPTER XIII

CENTRAL SCOTLAND

ON the north-west side of the series of faults which limit the Scottish Uplands, the older Palæozoic rocks have been let down to form what is commonly termed the Central Valley of Scotland, although within that region there are considerable areas of upland, in several parts rising well over 1,000 feet in elevation, while the proportion of actual lowland is small. Indeed, some of the higher areas abut on the Scottish Uplands and almost mask the distinction between the two regions.

Where Central Scotland adjoins the Highlands, however, there is a much more sharply defined boundary, for here a greater contrast in the relief has been brought about by another line of faults which runs from Helensburgh at the northernmost point of the Clyde estuary to Stonehaven on the east coast. This abrupt, almost wall-like, change from lowland to highland is broken only by deep valleys of the rivers which have trenched the highland edge where they enter the lowland. As along the two lines of faults the down-throw is on the inner side (see the geological section), Central Scotland is a rift valley in structure; hence the term Central Valley has perhaps more relevance for the geologist than for the geographer.

The phrase "the Lowlands of Scotland" has been used in ordinary speech to denote all the country south of the "Highland Line," i.e. both Central Scotland and the Scottish Uplands, for historically both these latter regions have been contrasted with the north, not only by their situation and physical characteristics, but also by their political development and by the ways of life and speech of their inhabitants.

The situation and greater fertility of the centre and south led to its settlement by many immigrants of Anglo-Saxon origin, and to the growth of a greater population than could be supported in the north; consequently the south became politically dominant and large towns developed. Moreover, the rocks of Central Scotland contained minerals which later made possible the rise of manufactures and commerce, and now the great

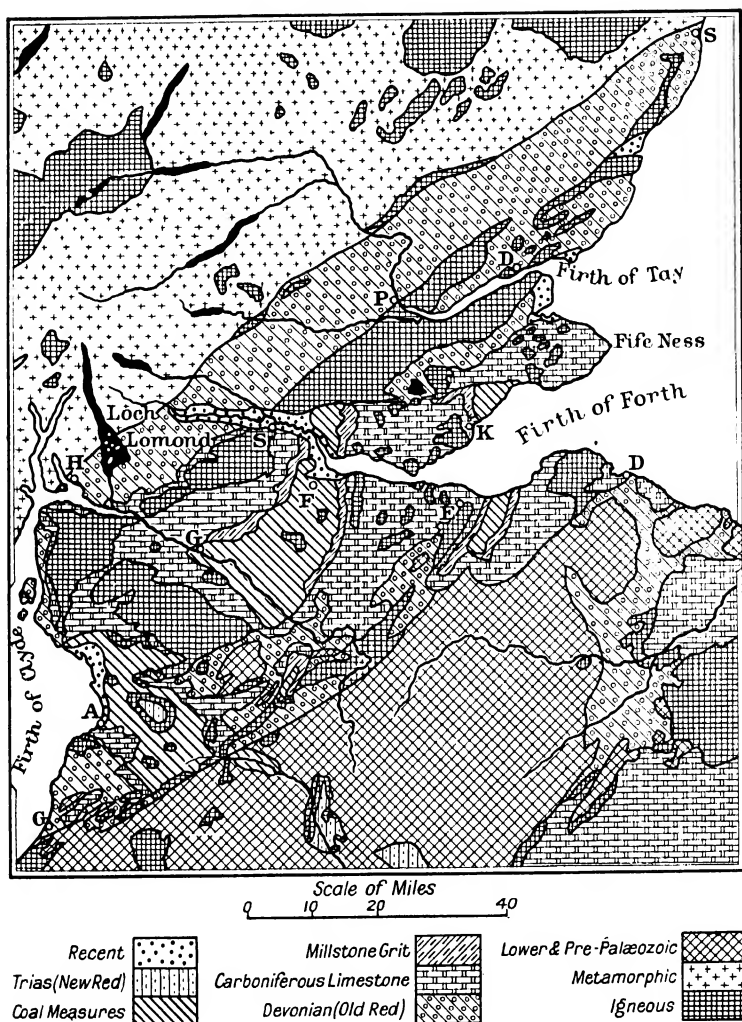


FIG. 48.—GEOLOGY OF CENTRAL SCOTLAND.

majority of the population of Scotland live upon the relatively small areas of actual lowland in the central part of the country.

Relief and Structure.—In the north-west of Central Scotland, immediately under the Highland edge, is a narrow lowland belt which stretches from coast to coast. It is one continuous, valley-like hollow, but it is drained by a series of

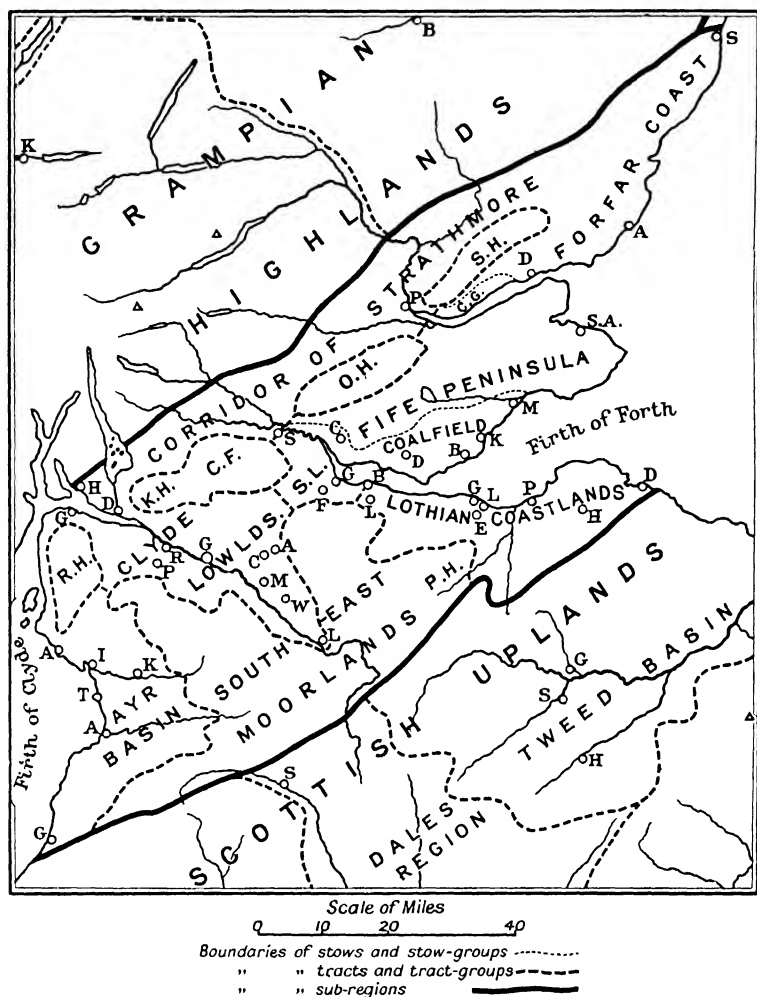


FIG. 49.—REGIONS OF CENTRAL SCOTLAND.

streams: from Loch Lomond the short River Leven flows to the Clyde; the Forth and its tributary, the Teith, cross it from the Highlands to the Forth estuary; the Tay and its tributaries, the Earn and Isla, drain the central portion to the Firth of Tay; finally, shorter streams flow across its north-eastern part to the North Sea. The central portion drained by the Tay is known as Strathmore, the great "strath" or wide valley as distinct from

“ glen ” or narrow valley ; as it is convenient to have one name for this lowland strip as a whole, it will here be termed the Corridor of Strathmore. Reference to the geological map shows that it is floored by a continuous belt of Old Red sandstone.

This corridor is almost completely shut in along its south-eastern side by a series of uplands : within the curve of the Clyde estuary are the Renfrew Heights ; east of the Leven and Clyde are the Kilpatrick Hills and the Campsie Fells, which reach nearly 1,900 feet ; between the lower Forth and the Tay are the Ochill Hills, which rise to over 2,000 feet ; north-east of the Tay are the lower Sidlaw Hills, continued by still lower hills almost to the east coast. As these uplands form a marked feature in the north-west of Central Scotland they may be referred to as the North-west Hills ; the geological map shows that in the main they are composed of a belt of igneous rock, exhibiting the same “ Caledonian ” trend as the Corridor of Strathmore. This belt is well marked in the section in Fig. 50, which shows in simplified form the structure along a line across Central Scotland drawn from north-west to south-east.

From this section it appears that the hollow of the Corridor of Strathmore is due to the wearing down of the Old Red sandstone and the resistance to denudation offered by the adjoining igneous rock. Further, the section shows that the strata in Central Scotland have been markedly folded, and even faulted. The disturbances clearly took place after the deposition of the Carboniferous rocks which are involved, and are therefore Hercynian in date ; their folding has had a great influence on the present-day geography, for it led to the formation of coal-basins in which the coal was preserved when it was worn away from the higher areas.

Coal-mining, however, is not limited to the Coal Measures, for in Scotland valuable seams are found among the varied strata which are mapped under the name of “ Carboniferous limestone.” Consequently, the area of the coalfields extends in the basins beyond the margin of the Coal Measures as shown in the geological map and section.

Although the foldings were due to the Hercynian earth movements, the directions of these folds were greatly affected by the block of ancient, hard rock of the Scottish Highlands in the north-west, against which the later rocks were thrust.

It is for this reason that the Corridor of Strathmore and the North-western Hills have the earlier, Caledonian trend.

The crumplings of the Carboniferous layers, however, are even more complicated. If the axes of the foldings had only the south-west to north-east direction, long troughs of the Coal Measures would have been formed, but actually the troughs are broken up into basins by cross-foldings. One very marked cross-folding has bent up the strata along an axis more or less at right angles to the Caledonian direction, between the coastal lowland of Ayrshire and the valley of the Clyde; it has brought up a mass of igneous rock forming moorlands separating the drainage to the coast of Ayr on the west from that to the Clyde on the east. Moreover, it has separated the coal-bearing strata of the coal-basin of Ayrshire from those of the

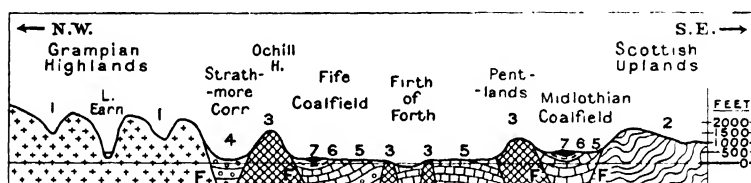


FIG. 50.—SECTION THROUGH CENTRAL SCOTLAND.

- | | |
|------------------------------|---|
| 1 = Metamorphic Rock. | 5 = "Carboniferous Limestone" (Calcareous Sandstone). |
| 2 = Lower Palaeozoic Strata. | 6 = Millstone Grit. |
| 3 = Igneous Rock. | 7 = Coal Measures. |
| 4 = Old Red Sandstone. | |

central coal-basin which extends from the Clyde valley above Glasgow in Lanarkshire north-eastward past Falkirk in the county of Stirling, and even across the estuary of the Forth into the county of Clackmannan.

The Ayr coal-basin has been partially submerged by the subsidence which has formed the Firth of Clyde, and the continuity of the central coal-basin has been broken by the estuary of the Forth, though mining is continued some distance beneath this estuary by galleries leading from pits on each shore.

On the north-western side of the central coal-basin the Carboniferous strata have been let down by faults which bound the southern scarps of the Sidlaw and Ochill Hills. Consequently, there is a narrow belt of lowland extending along the line of Carboniferous limestone from the Clyde below Glasgow to the Forth below Stirling. Along this lowland the Forth and

Clyde canal has been constructed, and the belt may be conveniently called the Forth-Clyde Corridor. Moreover, this lowland corridor is continued westward to the coast of Ayr between the Renfrew Heights and the moors which are formed by the upfold between the Ayr basin and the middle Clyde valley.

Another axis of up-folding is situated to the east of the central basin of Coal Measures; this axis runs almost from south to north across the Firth of Clyde west of Edinburgh. It is not to be seen in the present relief, and it has been interrupted by the subsidence of the land in the neighbourhood of the estuary, but it can be located on the geological map by the area of the Carboniferous limestone between the Coal Measures near Falkirk and those east of Edinburgh.

These latter strata have been preserved in another coal-basin, with a south-to-north trend, and give rise to the Midlothian coalfield on the south side of the Firth of Forth, continued beneath the waters of the estuary in the Fife coalfield east of Kirkcaldy. As in the case of the coal-basin crossing the upper part of the Firth, mining is extended below the waters from both shores.

There are, consequently, three main basins of Coal Measures, viz. that of Ayr, that of Lanark-Stirling-Clackmannan and that of Midlothian-Fife. But because here in Central Scotland coal-seams are found also in the Carboniferous limestone which outcrops around these basins, the actual mining areas are more extensive. In two cases this extension is important: the first is on the northern side of the Lanark-Stirling-Clackmannan basin where the coalfield continues under the Forth-Clyde Corridor to the neighbourhood of the town of Stirling; the second is in the south of Fife where mining is almost continuous from the Clackmannan Basin past Dunfermline and Kirkcaldy to the mouth of the Fifeshire River Leven.

The mining areas may therefore be marked out differently from the coal-basins, and are sometimes grouped into four coalfields arranged in order of importance as follows:

(i) The central coalfield in Lanarkshire, Stirling and Clackmannan, with more than half the total production of Scotland and about equalling that of Lancashire; (ii) the Fife coalfield behind the south shores of that county; (iii) the Midlothian coalfield east of Edinburgh; (iv) the Ayrshire coalfield, mainly productive in the valleys of the Ayr and Irvine rivers. There

is also a relatively unimportant coalfield in a small detached coal-basin drained by Douglas Water, a tributary of the Clyde south of the town of Lanark.

The higher parts of the Central Valley which have not yet received mention are due mainly to the outcrop of other masses of resistant rock. Thus in the centre of the peninsula of Fife a mass of igneous material has given rise to the Lomond Hills.

Also, in the south of Central Scotland near the edge of the Scottish Uplands, foldings have brought up belts of resistant igneous and Old Red rock in the south of Ayr and Lanark which rise as moorlands and mask the junction of the "Valley" with the Scottish Uplands. Moreover, faultings have brought up a horst of similar resistant material, which forms the Pentland Hills running south-west from Edinburgh.

Thus in the southern part of Central Scotland, as the result of up-folding and up-raising together with the greater power of resistance of some of the rocks, there is a considerable area of relatively high country. This appears to extend the Scottish Uplands north-westward into the lowland area in two broad moorlands: a western one between the Ayr Basin and the middle Clyde valley, and an eastern one between this valley and the Firth of Forth. As all this area is situated along or near the south-east side of Central Scotland, it may be given the general name of the South-east Moorlands region.

Returning to the consideration of the north-west part of Central Scotland, we note the remarkable gaps in the line of the North-west Hills where the Tay, the Forth and the Clyde cut across the belt of igneous rock. To explain the existence of these gaps, we must introduce a little more of the geological history of the region.

It appears that after the Hercynian movements, the whole Rift valley, with the igneous and folded rocks of the Old Red and Carboniferous periods, formed part of a plateau. The surface of this plateau was almost flush with that of the Highlands on the north-west, and dipped gradually to the south-east, where it joined the Scottish Uplands. The surface of the Rift valley was, in fact, part of an uplifted peneplain showing the graining of the strata along the directions of the earlier upfolds; e.g. immediately south-east of the edge of the rocks of the Highlands was the belt of Old Red sandstone and south-east of this was the belt of igneous rocks. Across these belts on the plateau ran rivers, the

forerunners of the Forth and Tay, beginning in the Highlands area and continuing across at least the northern part of Central Scotland. These rivers cut down their valleys through the various rocks in their courses, including the igneous belt where now are the gaps at Stirling and Perth ; these gaps are therefore occupied by reaches of the rivers which flowed south-eastward in accordance with the tilt of the plateau, and are therefore to be regarded as "consequent." Gradually tributaries of the main streams wore down the less resistant belt of Old Red sandstone, and so produced the longitudinal hollow of the Corridor of Strathmore, drained by subsequent tributaries or subsequent reaches of the Forth and Tay. The igneous belt has been much less denuded and, apart from the gaps, still remains as the series of North-west Hills, while the less resistant Carboniferous rocks to the south have been worn down to lowlands. The present rivers Forth and Tay, with the striking gaps in the igneous belt, are therefore examples of a superimposed drainage system.

The lower Clyde occupies a similar gap farther west, but traverses it in the reverse direction. The Clyde is thus an exception among the larger rivers of Scotland, which run more or less to the east and drain to the North Sea. Its anomalous direction is due to the subsidences off the west coast, which have given a relatively steep gradient to westward-flowing streams and enabled them to cut backward into the interior. In this way the lower Clyde has captured the drainage from the middle and upper parts of the river system. The Clyde has thus become an obsequent stream, with great economic significance as giving an outlet to the Atlantic Ocean and to transatlantic lands.

The subsidences at both ends of Central Scotland have reduced the extent both of the fertile lowland and also of the eastern and western coalfields, but they have facilitated access to the remaining productive areas.

On the other hand, slight risings of relatively recent date have brought above sea-level strips of land previously submerged and covered with marine sediments ; these now form coastal terraces or "raised beaches" which, after draining, have become very fertile. Such areas of flat, reclaimed land are known as "carse-lands," and among them may be mentioned, as being of special value, the Carse of Gowrie along the north-west shore of

the Firth of Tay west of Dundee, and the Carse of Stirling on the south-west side of the estuary of the Forth between Stirling and Bo'ness.

Constituent Regions of Central Scotland.—*The Lothian Coastlands.*—Natural advantages and thorough utilization have rendered this lowland tract bordering the Firth of Forth one of the most important regions of Britain. Raised beaches and glacial deposits of varied types have been cultivated for centuries and for long have made the region the home of a considerable proportion of the population of Scotland. Its position gave it easy access to England by the East Coast route and to other lands by its seaboard; a succession of peoples entered and contacts were made which aided its development, though occasionally the passage of armies brought battles, as at Dunbar and Prestonpans, and devastation to its territory.

In the narrow gap between the Pentlands and the Firth, a volcanic crag rose abruptly to a height of 200 feet and formed a site for a castle to guard the gateway. This castle for long held the king's palace, though the royal residence was later transferred to the adjoining abbey of Holyrood. Between the two grew up a royal burgh, and Edinburgh became the seat of the Scottish parliaments, and after the Union of Scotland and England, remained the metropolis of the northern part of the Kingdom.

The Lothian country is divided into three counties: West Lothian or Linlithgow; Midlothian or Edinburgh; East Lothian or Haddington. Each extends from the immediate coastal strip, across a fertile belt in the centre of which the county town is situated, and on to the moorlands behind; the political units thus cut across, and share in, the various features of the region which in general have an approximately west-to-east trend. Even in details of the topography this trend is noticeable, for it corresponds with the direction of the lines of drumlins which diversify the landscape.

The narrow coastal strip is low, often with rather saline soils encouraging the development of meadows rather than arable fields; along it are scattered fishing villages and ports. Inland, there follows a broad belt of sometimes level, but mostly gently rolling, lowland across which a remarkably intensive type of farming extends to an elevation of about 500 feet. On this belt are large farms in which much wheat, barley, oats and

potatoes are grown as cash crops ; on the broad northward-curving lowland of East Lothian, barley is the most important crop. Root-crops are produced in rotation courses and used for cattle, kept for milk only near the urban districts and elsewhere for beef, and for some sheep. Behind this arable strip, and extending to about 1,000 feet on the slopes of the moorlands, is a belt of grassy pastures in which there are few settlements.

Reference has already been made to the coalfield of the Esk valley, east of Edinburgh ; along the course of the stream are scattered the works of a considerable paper industry which uses the river water. West of the metropolis the lower Carboniferous rocks include shales from which oil is extracted ; their existence is too clearly shown by huge red dumps of waste.

In Edinburgh and its suburbs numerous small industries have arisen, largely because of the local labour supply, the local market and the existence of good means of communication—all bound up with the metropolitan character of the burgh. Printing works, textile factories and clothing establishments are clearly related to local needs ; breweries and distilleries use the barley of the neighbouring country, and their products are widely distributed ; mills and factories work up into a great variety of commodities the timber, oils and food-stuffs imported through Leith.

Leith and Granton, the more recently established port which is situated a couple of miles to the west, form the chief entry into Scotland for produce from the Continent, largely food-stuffs, but their export trade is small. Together they rank in the third group of British ports.

For a number of purposes Edinburgh is the administrative centre of Scotland, and with its traditional importance it has become the seat of many important institutions, e.g. the national library, a famous University, and the headquarters of scientific, literary and artistic societies.

The city is renowned among those of Europe for its natural setting and its architecture. The spacious and well-built thoroughfare of Princes Street is open on one side to public gardens laid out in the drained hollow of an old lake ; across them it looks to the bold profile of Castle Hill with the fortress standing high above the precipitous basaltic “crag” at one end, and a line of old buildings descending the gradual morainic “tail” to the other. A mile eastward rises to over

800 feet the igneous mass of Arthur's Seat with Holyrood Palace beneath its steep slopes, and the neighbouring, lesser height of the Calton Hill, the site of the new Government Buildings.

From this nucleus, Edinburgh has grown southward to the Pentland Hills and northward to the Firth of Forth, where its boundaries include Leith and Granton. Eastward and westward it is still spreading over the farming country, and its population of nearly half a million is still increasing.

The Stirling Lowlands.—This name is adopted as a convenient designation for the lowland tract draining to the Forth west of Bo'ness and extending as far as the city of Stirling. It includes the fertile Carse of Stirling on the western side of the Forth estuary, where coalpits have been sunk through the clays of the raised beach and the pit-heads rise above the meadows and fields.

The region also includes the eastern part of the Forth-Clyde Corridor; this is drained to a small river, the Carron, which winds through the flat country north of Falkirk and joins the Forth at Grangemouth where the Forth and Clyde canal also enters the estuary. In this southern district the coal-mining has been associated with the working of iron-ore, which in Scotland is found fairly widely distributed in the Coal Measures, particularly in the central field where most of the ore is now obtained. There is some iron-smelting at the Carron Iron Works north of Falkirk, and there are steel works in the same neighbourhood. Local supplies of ore and pig-iron are supplemented by import through Grangemouth, whence the steel products, as well as coal, are exported; smaller shipments of coal are made at Bo'ness.

The importance of the position of Stirling as a centre of routes, both those through the more populated parts of Central Scotland and also those joining the Highlands and Lowlands, can be realized by a study of the map, particularly when it is added that Stirling was until recently the lowest bridge-place of the Forth.

In connexion with the strategic position, a volcanic rock overlooking the river provided a defensible site for a castle, and adjoining this the town grew up; the Battle of Bannockburn was fought a mile or two to the south. Stirling is now naturally a fairly important railway junction, but it has not become the seat of any great industry.

The Clyde Lowlands.—This tract includes the area, approximately below 600 feet, drained by the middle and lower Clyde, and the neighbouring parts of the Forth-Clyde Corridor which are drained by tributaries of the same river, both on the east and on the west of the main valley. The position of the region between the Firths of Forth and Clyde and its direct access to the Atlantic give it obvious commercial advantages, and these have enabled it to utilize its resources of coal, iron-ore, fire-clay and limestone in the development of iron and steel industries.

There are blast-furnaces for smelting, which is carried on mainly on the eastern edge of the Clyde valley at Airdrie and Coatbridge, Motherwell and Wishaw, as well as at Glasgow, while at or near the same centres are steel-works, using imported as well as home-produced iron. On this eastern side of the valley, in Glasgow and other settlements by the river, and also in Paisley and Johnstone on the western side of the valley, metal working of one kind or another is the leading industrial occupation. Many steel products are obtained; these include structural material, locomotives and boilers, machinery for textiles, sewing machines and scientific instruments.

The most famous branches of the industry, however, are connected with shipbuilding and marine engineering. These are carried on along the banks of the river, from Glasgow itself with its suburb Govan, for 20 miles down-stream, by Clydebank, where some of the biggest liners in the world have been built, and Dumbarton to Greenock. The Clyde shipbuilding industry, like that of the rest of Britain, has declined in recent years, but it is still important and is responsible for about one-third of the British production. It was developed with one natural handicap, for while there is deep water in the lower part of the estuary, nearer to Glasgow much deepening and dredging has had to be done. Before these works, although Glasgow was the lowest bridge-place, the shallow stream could be forded at low tide for several miles below it; there is much truth in the saying: "The Clyde made Glasgow, and Glasgow made the Clyde."

Two special factors have aided the concentration into this area of a number of industries which in England are located in separate regions. One is the relative isolation of Central Scotland from the industrial districts of South Britain; the local production of the various goods needed by the Scottish people

led to the early establishment of crafts with skilled labour, and the later industrial developments were assisted by the existence of the local market. The second factor is the narrowness of the crossing from the Atlantic entry to the shores of the North Sea ; this facilitates the manufacture of raw materials obtained from the one side into commodities exported from the other.

A cotton industry grew up in the Clyde Lowlands with the same advantages as those possessed by South Lancashire : soft water, water-power, easy access to transatlantic supplies of raw cotton, coal, facilities for the local production and repair of machinery. But the attraction of capital, organizing ability and labour to the iron and steel industries appears to have starved the cotton industry of supplies of these necessities ; consequently it has declined, being now limited to the spinning of sewing cotton and thread at Paisley, fine weaving of Lancashire yarn at Glasgow, and the finishing of local and Lancashire fabrics where clear water is to be obtained in the Leven valley and from the neighbouring moorlands.

A woollen industry has, on the contrary, never greatly developed, though carpets and some other woollen goods are manufactured at Glasgow and Paisley, while clothing is made to a considerable extent at Glasgow from cloth and other materials produced elsewhere.

Important chemical industries have grown up in association with the coal-mining and the metallurgical and cotton industries, of course aided by their position near the great water-way. Sugar refining at Greenock and elsewhere, and the preparation of tobacco and food-stuffs, are clearly related to facilities for import.

Glasgow stands in the second rank of British ports, and has an unusual characteristic in that its exports normally exceed its imports in value. It exports most of the goods produced for foreign markets in Central Scotland, but it has no great import of raw materials ; e.g. the cotton comes, as raw cotton, yarn or fabric, from Lancashire. Moreover, unlike the great ports of South Britain, it does not import food for large populations beyond its immediate locality ; indeed, many of the needs of the region itself are largely supplied through the ports of Grangemouth and Leith.

In spite of, and indeed assisted by, the industrial and commercial developments, farming is the main occupation of the

greater part of the region. The needs of the urban population combine with the cool, wet climate to direct this work primarily to the keeping of cattle and the production of milk and beef, but there is the subsidiary growing of root-crops, oats and potatoes ; also, in the narrower part of the Clyde valley below the town of Lanark fruit is grown for the making of jam.

The industrialization of the urban areas has had its undesirable aspects as markedly as in any other part of Britain ; the smoke-blackened line of depressing settlements from Airdrie to Wishaw and the crowded, unhealthy slums of Glasgow have presented difficult problems to a generation which regrets its unplanned and short-sighted creation. The larger centres have been able to make great improvements, however, and the central part of Glasgow is now spacious and well-built.

The Burgh of Glasgow has a population of over a million persons, and is still increasing, though more slowly than in the past ; it is the " regional capital " for the most populous part of Scotland and the seat of a great University. The more outlying parts of the conurbation of which it is the centre include another quarter of a million people, and the water supply for this great population has to be drawn from Loch Katrine in the Highlands. With the settlements along the lower banks of the Clyde, and those near the eastern and western sides of the valley, the population of the whole region is well over a million and a half persons, about one-third of that of all Scotland.

The South-east Moorlands.—Rising sometimes gently, and elsewhere abruptly, from both sides of the Clyde valley are the broad areas of upland, which increase in extent and elevation towards the south-west and the south-east till they join the Scottish Uplands. In their generally level, rolling surfaces they show clear evidence of their origin as remnants of uplifted peneplains.

The lower plateau areas are farmlands or sheep pastures ; the upper are often great expanses of heather, but sometimes are covered with sedges and other damp-loving growths, and occasionally are mere peat-bogs. The diversity of conditions requires the region to be regarded as a tract-group rather than as a single tract.

The South-east Moorlands have few economic resources : the farms of the lower parts are largely under grass and aim at sheep-rearing ; in the area east of the lower Clyde valley and

south of Falkirk, where the Coal Measures extend beneath the moors, there are occasional small and squalid coal-mining settlements; south-west of Lanark is the little detached coal-field of Douglas. At the meeting of routes which cross the region there are a few large villages or small towns, but otherwise the country is almost uninhabited.

The Falls of Clyde are situated where the river leaves this moorland country to enter the lowland near Lanark; they are utilized to supply electric power to the Clyde industrial region. The waters of the Pentland Hills are stored in reservoirs for the use of Edinburgh, but having proved insufficient they are now supplemented by supplies from the Scottish Uplands.

The Ayr Basin.—This tract is the wettest of the lowland regions of Central Scotland, with an average rainfall of about 40 inches; most of it was originally bog-land, but is now reclaimed and devoted to dairy-farming, producing milk in the northern part near the industrialized areas and butter and cheese farther south. Potatoes are another product of the region. It is by no means monotonous country, having woods scattered among its fields, and being diversified by low hills and by valleys, in which the winding streams converge towards the central part of the coast-line.

In the valleys of the rivers Ayr and Irvine are most of the pits of the Ayrshire coalfield. Much of the coal is sent away either by land or by sea, from the port of Ayr or the smaller shipping points of Troon, Irvine or Ardrossan; most of the remainder is utilized in the industries of the northern part of the region. These industries are similar to those of the Clyde valley, for they have been influenced by similar physical and historical factors. Iron-ore is mined and smelted in the western part of the lowland corridor, which leads from Glasgow south of the Renfrew Heights to the coast. An iron and steel industry has developed in the Irvine valley, with the advantage of direct import and export *via* Irvine, the chief centres being at that town and to a greater extent at Kilmarnock; here, among other works, are railway construction shops. Chemical works are also situated in this district. Textile industries grew up where water-power was available, and in the upper valley of the Irvine there is still a fair amount of lace-making. A woollen industry has survived, as in the carpet and hosiery factories of Kilmarnock and the making of hosiery and other

knitted goods at Ayr. Ayr is the largest town, for in addition to its small manufactures and its shipping activities, it is the chief market centre of the region.

The North-west Hills.—Although these uplands often have steep slopes and in some parts marked scarps, the gently rolling upper surfaces show that they are residual portions of the dissected plateau, and as the rock yields soils of moderate fertility they have a grass cover which supports flocks of sheep almost comparable with those of the Scottish Uplands. Ill-drained flat areas have peat-bogs, and heaths once covered much of the hills, but pasture has been extended and improved till the prevailing colour, especially of the Ochill Hills and the Sidlaw Hills, is a bright green rather than the brown and purple of the heather.

The Peninsula of Fife.—Until recent times this tract was almost isolated from the rest of Scotland by the Firths on the north and south and by the Ochill Hills on the west ; it has now been brought into closer relations by the improvement of communications and especially by the construction of the Tay Bridge which joins it to Dundee, and the Forth Bridge which takes advantage of the projection of an igneous outcrop into the Firth of Forth at North Queensferry. Fife, therefore, now lies athwart the East Coast route to the North, and has shared in the economic development of Scotland. The peninsula is a composite tract, for in structure, landscapes and development it is by no means uniform ; it includes a central lake-filled basin surrounded by grassy heights, woods and parklands, fertile arable lands and industrialized mining areas.

Much of it is productive farming country ; in the south and south-east a fair amount of wheat is grown in the common rotations, in the east barley also has some importance, but everywhere oats is the main cereal ; these are mainly cash crops, and a greater proportion of the land is under rotation grasses and root-crops for the cattle. Large numbers of these are bought for winter feeding, and sold off in spring and early summer ; this type of mixed farming prevails in the coastal areas, but the central region of the Kinross Basin, in which is Loch Leven, has much gravely glacial deposit and accumulations of peat, and is more given to stock-raising, while the hilly districts are sheep-lands.

In the centre of the north-eastern coast is the city of St. Andrews, where the first University in Scotland was founded ;

north of it, shown on the geological map as of " recent " formation, is a great accumulation of sand partly overgrown with heather and grass, and near St. Andrews utilized for the famous golf-course.

Behind the south coast is the *Fife coalfield stow*, where between the farm-lands are large, straggling groups of houses, pit-heads and pit-banks, while along the shores of the Firth are industrial towns and ports. Methil, by the mouth of the River Leven, exports a large amount of coal, and so, too, does Burntisland farther west. Here a return cargo is furnished by bauxite, the ore of aluminium from Southern France, and this economical transport, and the adjoining supplies of fuel, have led to the production at Burntisland of alumina, a substance intermediate between the ore and metallic aluminium. Situated between these shipping points, Kirkcaldy uses much coal for its industries which include the making of oil-cloth with jute-cloth from Dundee, and linoleum with cork from Spain. Linen is woven at several centres in this region, among them being Dunfermline which produces damasks and other goods of high quality.

There is scarcely a break between the coalfield in the county of Fife and that in the county of Clackmannan which forms the south-western extremity of the peninsula ; in this latter area there is a much smaller production of coal, and no great industrial developments have resulted from the mining, though some woollen goods are produced at the small shipping port of Alloa.

The Carse of Gowrie.—Situated on the north-west shore of the Firth of Tay west of Dundee, this stow is sheltered on the north by the Sidlaw Hills and on the south-west and south by the Ochill Hills and their continuation along the south side of the Firth. Consequently, it escapes a heavy rainfall and is protected from some of the colder winds, and with the reclamation of its originally marshy but fertile soil of silt and clay, it has become one of the most productive areas of Scotland. Most of the land produces grass and fodder crops, and the main work of the farmers is the fattening of cattle bought in the spring and sold again in the autumn or during the winter. Also barley, wheat and oats are grown, the latter extending even up the south-facing slopes of the Sidlaw Hills. By the shores of the Firth there are orchards producing apples, pears, plums and other fruit used in the jam-making at Dundee.

The Corridor of Strathmore.—Like all the lowland regions, this

tract has a thick mantle of glacial deposit, but here as elsewhere the subsoil provided much of the material which the ice redistributed ; consequently the Old Red sandstone has given a generally fertile soil to the region. Strathmore itself, drained by the Tay and the Isla, is a level, or gently rolling, productive land of mixed farming, which raises large numbers of cattle and receives others from less-favoured areas for fattening ; most of the land is cultivated, with rotation grasses, root-crops and potatoes. Cereals also are grown to a considerable extent, mainly oats but also some wheat, for Strathmore, like the east coast, has a relatively low rainfall. Farther west, the parts of the Corridor drained by the Teith and Forth are less favoured ; drumlins and kames (glacial accumulations like eskers but much shorter) are more noticeable, and a considerable area is still an unreclaimed peat mass ; moreover, the rainfall is greater and the land is largely pastoral, supporting both cattle and sheep. The westernmost area, near Loch Lomond, is also pastoral country, with dairy farms supplying the neighbouring Glasgow population, and the valley of the Leven has been invaded by dye-works as well as by residential settlements.

In each of the gaps which lead from the Corridor through the North-west Hills a town has grown up, but while Dumbarton at the mouth of the Leven has shared in the industrial development of the Clyde valley, and Stirling may be best considered in connexion with the lowlands of the Forth estuary, Perth on the Tay is situated more definitely within the Corridor. Its importance, however, is due to its nodal position. At a defensive point on the main roads into the Highlands, Perth was a Roman station and an ancient capital of Scotland ; until the construction of the great bridge over the Firth of Tay, it was the lowest crossing-place of the river and the meeting-place of routes joining the east coastal regions. Its importance is now obscured by the rise of centres in closer contact with the industrialized areas farther south, but it has large works for dyeing and bleaching.

The Forfar Coast.—The eastern end of the Strathmore Corridor is not sharply divided from the coastal area which extends from the north shore of the Firth of Tay towards Stonehaven ; moreover, the soils and climate are similar. Consequently, throughout these regions there are close similarities in the ways of life, apart from the existence of fishing villages and small ports along the coast.

By the entrance to the Firth of Tay, however, there has been industrial development to a small extent at Arbroath and to a much greater degree at Dundee. A linen industry was assisted by the ease of importing flax from the Baltic lands, coal being available from the coalfields adjoining the Firth of Forth ; this work still continues, though the jute industry which arose in connexion with it has become far more important. The jute is brought from India, and Dundee has almost a monopoly of the import of that material. The spinning of hemp is also carried on, and associated with the working of these textiles is the construction of textile machinery. Another important development is the preparation of jams, using fruit grown on the adjoining Carse of Gowrie and raspberries from Strathmore, and also the making of marmalade, as this latter provides work at a different season of the year ; with these industries has naturally grown up the manufacture of other preserves and confectionery. As a result of its varied development, Dundee now has a population of nearly 200,000 people, and is the third largest town of Scotland.

Although the lowlands north of Stonehaven are not sharply demarcated from this north-eastern corner of Central Scotland, and indeed share some of its characteristics, yet in general the Highland Line from Helensburgh to Stonehaven marks the beginning of country of a distinct type which becomes increasingly different in the more northerly latitudes.

The closely interrelated tracts of Central Scotland therefore form a small but definite sub-region, and the remaining sub-regions of Scotland will be studied in the following chapter.

CHAPTER XIV

NORTHERN SCOTLAND

NORTH of the fault-line from Helensburgh to Stonehaven, Scotland consists of blocks of ancient rock ; in the west they are true Highlands, but in the east they descend gradually and assume the form of peneplains rather than that of dissected plateaus. The area of lowland in north-east Scotland has been greatly reduced, however, by the subsidences beneath the North Sea, particularly in the great triangular inlet between Duncansby Head in Caithness and Kinnairds Head in Aberdeen. Consequently the peneplain regions of the North-eastern Lowlands remain in the broad area behind Kinnairds Head to which the name of Buchan Peninsula has been applied, the narrower coastal lands around Moray Firth, and the smaller Caithness Lowland behind Duncansby Head.

There is also a marked difference between the west and the east of the country due to climatic contrasts. As regards temperature conditions, while the western coasts and islands have at sea-level a mean temperature during January of over 40° Fahr., i.e. equal to that of the coast of Sussex, the east of Scotland has large areas with a temperature below 38° Fahr., i.e. equal to the coldest parts of Eastern England ; the effect of the westerly winds is clearly apparent. In July, there is a less clear distinction to be seen from the run of the isotherms, but if any place on the west coast is compared with one in the same latitude on the east, the former will be found to have a rather lower temperature.

As regards rainfall, the contrast is much more marked. Over most of the Western Highlands the annual total ranges from about 60 inches to over 100 inches, while even 150 inches is received in the neighbourhood of Ben Nevis. On the contrary, along the eastern coast is a narrow belt where the rainfall is less than 30 inches, and most of the North-eastern Lowlands have little more than 30 inches per annum.

The broad generalization is therefore justified, that the whole of the west is relatively equable and distinctly rainy, while the

east coast is more "continental." But it must be remembered that the above statements as regards temperatures apply only to places at or near sea-level, and that the great differences in elevation need allowances to be made for them. Consequently much of the Highlands region has considerably lower actual temperatures than those mentioned; the mean in July is generally less than 52° Fahr., and that in January being less than 32° Fahr., the freezing-point of water.

The North-eastern Lowlands.—Correlating the facts cited above, it appears that in the north-east of Scotland, i.e. north of Stonehaven, around the Moray Firth and in Caithness, there are extensive areas of low relief which experience higher actual temperatures in summer and considerably less rainfall than the Highlands proper; moreover, large parts of these north-eastern areas are underlain by less resistant rocks and have better soil conditions, and in consequence support a considerably larger population than the rest of Scotland north of the "Highland Line." The combined effect of the differences in relief, structure, climate, productivity and the conditions of human life is so marked that the region cannot be regarded geographically as part of the Highlands, but forms a distinct sub-region to which the term North-eastern Lowlands may be applied. We will now deal in turn with each of its constituent tracts.

The Buchan Peninsula consists largely of schist, gneiss and granite, which has been worn down to the state of a peneplain, of which the general tilt is indicated by the eastward flow of the Dee and the Don; the broad valley of the former river extends into the Highlands between two belts of resistant granite. The region has been heavily glaciated, but the boulders have been cleared, the peat-bogs drained and much of the land utilized for crops and grass or as productive woodlands. The chief characteristics of the climate may be appreciated by a careful examination of the graphs for Aberdeen and other places in Figs. 15 and 16; specially noteworthy are the relatively low summer temperatures as compared with the more southerly stations, and the frequency of snow in winter and early spring.

The chief aim of the farming is the raising of cattle, mainly for beef, and in a six-year rotation the fields may be for three of the years under grass, for two years under oats and for one year under root-crops, probably turnips or swedes. A cash

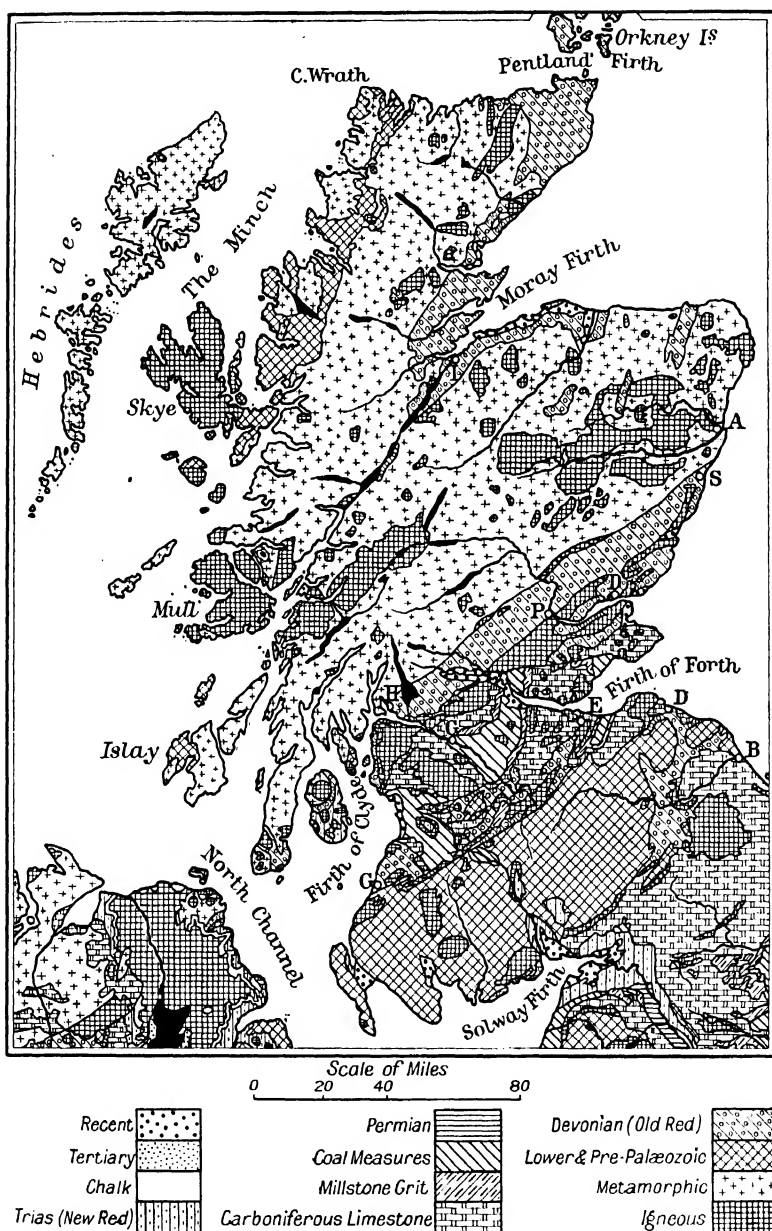


FIG. 51.—GEOLOGY OF SCOTLAND.

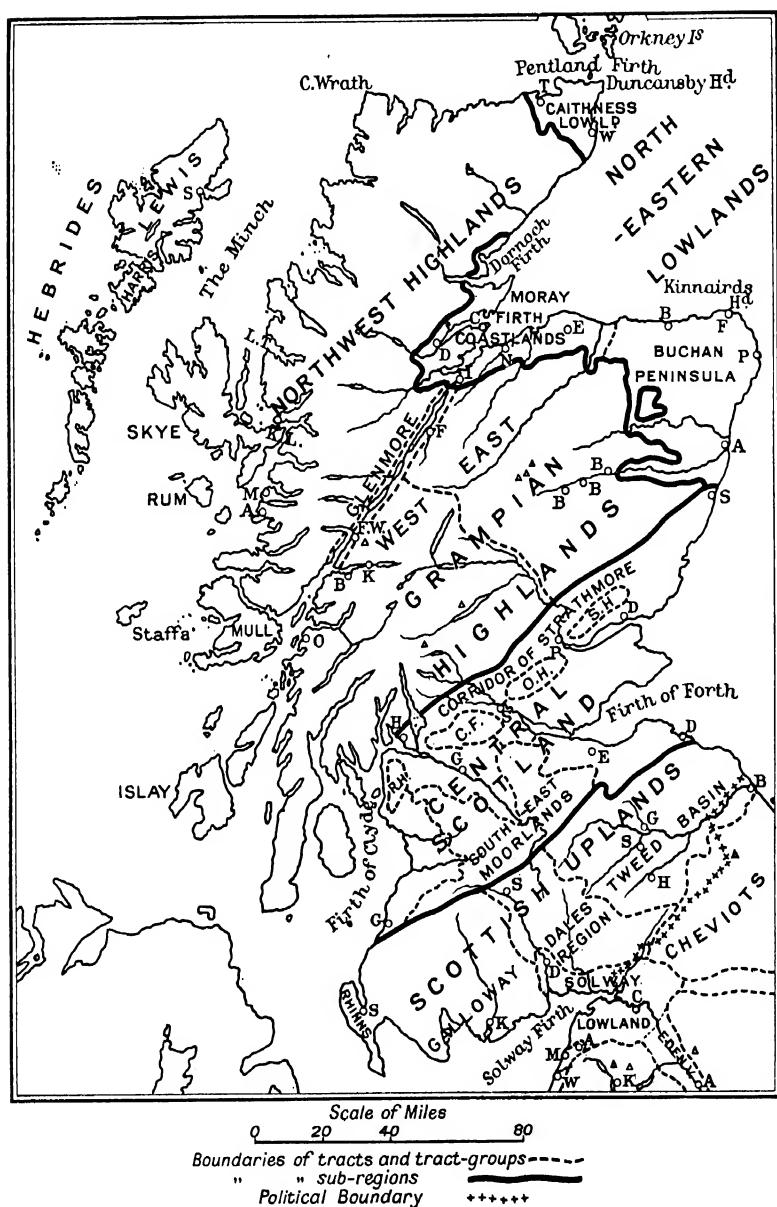


FIG. 52.—REGIONS OF SCOTLAND.

crop is barley, of which the production on a large scale has here its most northerly situation in Britain. Wheat, however, is not grown to any extent. In connexion with the ripening of cereals, it must be remembered that though the summer temperatures are lower than those farther south, there is some compensation for the lack of heat in the slightly longer duration of daylight during summer in these northern latitudes.

The rural population is fairly evenly distributed over the region, and in the river valleys are small country towns, while along the coast are a number of fishing villages and towns; the largest of these are Fraserburgh and Peterhead, near the north-eastern corner, Banff on the north coast and Aberdeen, which is by far the most important in this connexion.

Aberdeen is the regional capital. Its position near the coastal entry to the North-eastern Lowlands is comparable with that of Edinburgh at the entry to Central Scotland. Its site is the lowest bridge-place on the Dee, the estuary of which affords harbourage for the port. Through this port are sent away fish, and also granite, the polishing of which is one of the local industries. The igneous rock indicated in the neighbourhood on the geological map is mainly granite, and Aberdeen has been termed "the granite city," because this material is so largely employed in its buildings.

The use of the port by fishing and other vessels aided a small boat-building and marine-engineering industry, and the water-power in the neighbouring valley of the Don was the origin of paper-making now carried on with imported coal and raw material.

For centuries, Aberdeen has been one of the chief cities of Scotland, and it has a University of ancient foundation. With its trade and industries, it has grown considerably, and now has a population about equal to that of Dundee.

The Moray Firth Coast-lands may be taken as including the lowlands around the mouths of the Spey, Findhorn and Nairn, and those around the drowned inlets of the Beaully, Cromarty and Dornoch Firths. They are generally similar to the Buchan Peninsula, but are underlain by Old Red sandstones, and in the interior portions they have a more sheltered position with a corresponding freedom from strong winds from the North Sea. They have a lower rainfall, and because of these rather better conditions, wheat here reaches its most northerly limit in Britain,

though of course grown only to a small extent. Barley is produced in greater quantities than in the Buchan Peninsula ; its cultivation is associated with the distilling of spirits. Otherwise, the farming is of the same general kind as farther east.

Speyside and the adjoining coastal belt have attractions for tourists, with fishing in the rivers, pleasant country with woods and low hills, and by the coast wide stretches of sands (shown by the geological marking as "Recent"), which form fine golf-links. Elgin is an ancient city near the eastern entrance to this region ; it is not on the coast, for the route avoids the wide mouth of the Spey and the belt of sands. In its inland situation, this city is exceptional, the other towns being either on the shores of the Moray Firth, like Nairn and Cromarty, or at the head of the inlets, like Dingwall and Inverness. The last-mentioned town is the largest ; its position at the focal point where the route through Glen More meets the coast roads is obvious, but the amount of traffic and trade in this part of Scotland is not great, and Inverness has remained a small town in comparison with those of the central parts of the country.

North of Dornoch Firth, rocks of greater resistance and consequently higher lands extend the North-west Highland region to the cliff-bound coast, and thus isolate the *Caithness Lowland*. Here, again, Old Red sandstones have been worn down to what is, in general, a rather bleak, monotonous plain, though high masses of sandstone form the bold cliffs of Duncansby Head. In this region, crops are less grown than farther south, and cattle rearing, the quarrying of flag-stones and fishing are the chief occupations. Wick and Thurso, small fishing ports, are the largest settlements.

The Orkney Islands.—To the preceding three tracts of the North-eastern Lowlands may be added the exclave composed of the Orkney Islands, although in the west of Hoy the land reaches over 1,000 feet and rises from the sea in magnificent cliffs, and on Mainland, the largest island, there are rough moorlands. The Old Red sandstone which forms the greater part of the rocks gives soils and opportunities for farming similar to those of Caithness ; both cattle and sheep are raised, and oats and roots are the chief crops. About a score of the larger islands are inhabited, and farming supports most of the small and decreasing population, for fishing is an occupation followed by relatively few of the inhabitants ; the chief, but small, town

is Kirkwall. The isolation of the people is increased by the frequent difficulty of communication with the mainland of Scotland due to the heavy seas and the rapid set of the currents through the Pentland Firth, which alternate in direction with the changes of the tide.

The Highlands.—The blocks of ancient and resistant rocks of which north-western Scotland is formed have had a history broadly similar to that of Wales, in so far as it includes folding of “Caledonian” date, subsequent peneplanation, and fracturing and uplift in the “Alpine” earth movements (see Appendix I). The fracturing during these last disturbances was very marked in the north-west, and this area was involved in the complicated subsidences of the Atlantic margin.

One great series of faults caused the line of weakness along which the deep and narrow trench of Glen More has been eroded. Crustal instability persists to a very small degree even yet, as is shown by earth tremors and slight earthquakes in the neighbourhood of Glen More and the Highland Line.

The faultings have allowed the blocks on either side of Glen More to be subjected to such differences in regard to their relative elevation, and the resultant dissection by streams, that their surface features have different characteristics. Consequently, Glen More separates the two main tract-groups, the Grampian Highlands on the one side and the North-west Highlands on the other; it is another example of an inter-regional stow.

The Grampian Highlands.—The term “Grampian Mountains” has been applied, rather indefinitely, to various areas. It is no longer used to denote the line of high country which rises almost like a wall above the lowlands of the Corridor of Strathmore, for this is now realized to be merely the notched edge of a plateau. The term is now more often used to indicate the higher residual portions of the block.

These have their greatest elevations nearer the north-western side of the Grampian Highlands. Here Ben Nevis, the highest mountain in the British Isles, reaches over 4,400 feet. It is an almost isolated mass, mainly of granite, standing as a huge and, as it were, rather clumsy bulk above the southern end of Glen More. Apart from Ben Nevis, the highest elevations are in the granitic area where Ben Macdhui rises to nearly 4,300 feet and Cairn Toul and Cairn Gorm also exceed 4,000 feet. Nearer to

Strathmore, the corresponding elevations are generally rather less, though Ben Lawers and Ben More rise to about 3,900 feet ; these last mountains are not granitic ; like the greater part of the Highland region, they are formed of metamorphic rocks, of which the most widely distributed are gneisses and schists.

The outstanding summits of the Grampian Highlands are probably monadnocks which were never worn down to the general level of the peneplain before its uplift, but their greater elevation in the west and north, and their progressive lowering towards the southern and eastern margins, broadly corresponds with the general tilt of the faulted block-masses ; apart from the monadnocks, the plateau level varies from over 2,000 feet to over 3,000 feet above sea-level.

The main river systems are to be associated with the structure. Consequent streams show a south-easterly direction corresponding with the general tilt of the plateau, while the subsequent and longitudinal courses have developed along the lines of relative weakness in the grain of the land and have captured long stretches of the consequent rivers. The course of the Spey is clearly longitudinal, while the other great Highland river, the Tay, exhibits both directions in its reaches. The Upper Tay, flowing through Loch Tay, is longitudinal, but where it meets the Garry, some distance below the lake, it turns south-eastward and follows the consequent, transverse direction of the smaller stream. The Dee and the Don have somewhat anomalous courses, which probably correspond to an eastern tilt of a peneplain surface in the eastern part of the region.

A marked characteristic of the rivers is their frequent opening-out into long lochs, which in some cases fill the narrow valleys and are bounded by steep slopes scarcely giving room for roads at their sides. Still more remarkable is the depth of some of these Highland lochs ; they may be hundreds of feet deep and their bottoms descend even below sea-level. This feature is very marked in Loch Ness in the fault-valley of Glen More, and still more strikingly in Loch Morar in the Western Highlands, which has a depth greater than that of the seas anywhere in the immediate neighbourhood of the British Isles.

As regards the formation of such lochs, the hypothesis of glacial scouring seems inadequate. Lochs of glacial origin elsewhere, as in the Cumbrian Region, do not show the characteris-

tic of very great depth, and these Scottish lochs are not found in the Grampian Highlands east of the transverse line marked by the Tay and the Garry.¹

Moreover, this type of loch is most closely associated with the fractured and fragmented Atlantic margin, and similar deep hollows are found in the sea inlets to which geographers apply the term "fiords." Indeed, it appears that these Scottish fiords are hollows of this type which have been submerged in the general subsidence along the west coast. A further fact regarding both the land valleys and the fiords is to be seen from the map: they occur in series almost parallel to one another along certain directions, e.g. some correspond to the Caledonian trend, some have a slight deviation from this as in the case of Glen More and its seaward continuation in Loch Linnhe, while an east-west direction is also common.

These considerations have led to the most likely hypothesis, namely, that the very deep valleys and fiords are essentially due to fissures in the earth's crust, i.e. they have a tectonic origin, though rivers have eroded along the weakened fracture-lines, and ice has scoured the shallower basins and deposited morainic bars.

It has sometimes been suggested that the extraordinary degree of dissection characteristic of the western parts of the Highlands is due to the very great precipitation of snow with the consequent accumulation of ice and intensification of ice-action in the past, since then followed by very great rainfall and the consequent run-off and erosion. This factor has doubtless operated to some extent, for the precipitation is greater than elsewhere in Britain, as has already been pointed out.

In general, the fiord inlets of Western Scotland are similar to those of Norway, though they do not reach so far inland nor are they bordered by such great heights; on the other hand, they are quite different from the "rias" of Southern Britain, which show the gradual deepening seaward to be expected from the drowning of a river valley of normal profile.

The Ice Age, with the formation of huge masses of ice over the region (see Fig. 14) and their outward flow in all directions, has left many important results in the Highlands: cirques, here called corries, are common at the heads of the streams; many of

¹ In passing, it may be noted that the Garry-Tay line, continued by the uppermost reach of the Spey, affords a useful, if approximate, boundary between the western and eastern tract-groups of the Grampian Highlands in several respects; this boundary is shown on the map of the regions of Scotland.

the valleys have U-shaped sections, and many have lakes of undoubted glacial origin ; larger glaciers deepened main valleys more than the side ones, which now enter the main valleys at a considerable elevation above the bottom and are therefore known as hanging valleys ; streams draining such hanging valleys descend to the main river in rapids or falls from which water-power may be obtained ; passes between the heads of valleys have been overridden by the ice, and so lowered that they afford easy routes for roads or railways.

The heavy precipitation upon the Highland area at the present time is a factor of wide significance, for in association with the other conditions, it helps to account for the prevalence of moors on the plateau areas and the difficulty of cultivating the lower lands. Most of the Highlands are moorlands or heaths, generally wetter and more ill-drained in the west and drier in the east ; at the greater altitudes and on steeper slopes vegetation is reduced to a minimum, but the sheltered valleys often have woods in which the silver birch or the Scotch pine is dominant.

Level land at low elevations is small in amount, occurring in coastal situations upon the raised beaches, and in inland districts in the broader valleys or as mere patches in the narrower glens. Yet even on these level areas the soils are sometimes almost useless, particularly in the west, for the excessive moisture may cause the accumulation of peat or an acidity in the soil which practically prevents cultivation.

The " crofts," as the holdings of the cultivable lands are called, are necessarily small, and the crofters live in tiny groups whose low white-washed houses, together with a shop and school and one or more " kirks," constitute the " crofting township," the typical rural community of the Highlands. The chief yield of the arable land is oats, potatoes and turnips, for generally the good land is too precious to be used for grass, but, in addition, the crofters have grazing rights on the rough pastures of the moors and heaths. They keep some cattle, particularly in the broader valleys of the interior and on the peninsulas and islands of the west coast ; sheep, however, are far more numerous, though not of course to the same degree as on the better pastures of the more southerly uplands of Britain.

Villages like enlarged crofting townships, and with an inn, are situated usually at nodal points in the valley systems, and are larger in the less dissected east, where the cultivable lands are

wider, e.g. in Strathspey and in the Highland part of the valley of the Dee. In the latter are well-known centres for migrating southerners : Braemar ; Balmoral, at which is a royal castle, in a setting where the country is diversified by fine forests ; Ballater, below which the valley opens out to the North-eastern Lowlands.

The moors and heaths are now largely in the occupation of sportsmen, as owners or tenants, who take their pleasure in stalking the deer, shooting the grouse and fishing in the streams ; they give occupation to a number of keepers and helpers of various kinds. The deer forests and grouse moors are most extensive in the east, but the deep and narrow glens of the west attract other visitors by the beauty of their scenery, with their wooded slopes and their gleaming lakes studded by verdant islets ; of such valleys the Trossachs below Loch Katrine is perhaps the most famous and most visited.

Still another sought-after area is the south-west coast and the adjoining isles, where mountains and sea, pleasant valleys and bold cliffs, offer many attractions and are visited especially by the inhabitants of the neighbouring Clyde region. Here, too, the relative mildness of the winter allows a greater variety of plant life, analogous in Scotland to that of the Devonian Peninsula in England. Fishing settlements are dotted along the shores and, again as in Southern Britain, in a number of cases they have grown into seaside resorts, particularly on the north-western shore of the Firth of Clyde and the islands of Arran and Bute.

Other resources of the Grampian Highlands are small ; what minerals there are no longer pay for working, though some quarrying is carried on. An important development is the utilization of water-power to obtain the electrical energy required for the reduction to metallic aluminium of the alumina already produced at Burntisland or Larne in the north of Ireland. For a number of years the Falls of Foyers, on the east side of Loch Ness, have been thus employed. More recently other works have been established at Kinlochleven, situated at the head of Loch Leven above Ballachulish ; here the water descends from the neighbouring Rannoch Moor, where a huge, lake-like reservoir has been constructed. Lastly, the greatest installation has been erected at Lochaber just north of Fort William, its water being led from the interior through a tunnel 15 miles in length, piercing the great barrier of Ben Nevis.

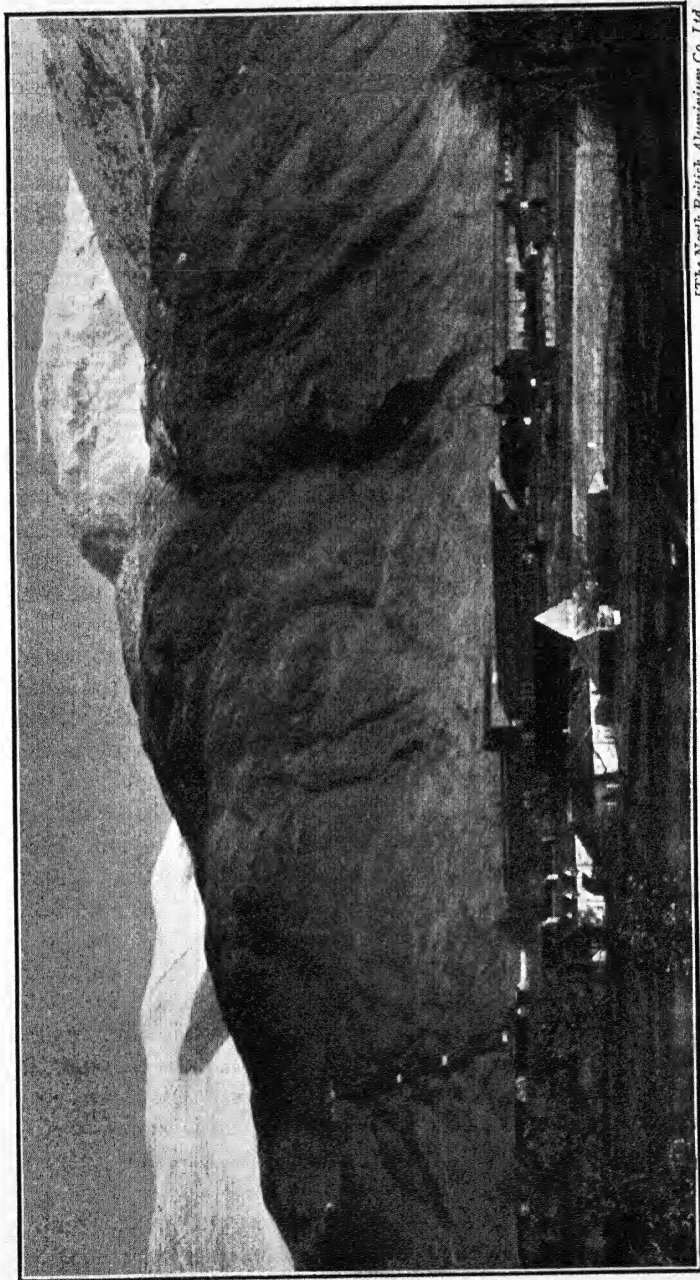


FIG. 53.—ON THE EASTERN SIDE OF GLEN MORE.

The bulky mountain mass rising towards the right is Ben Nevis; on the left are the exit of the tunnel which brings water fifteen miles through the mountain and the great pipe-lines leading to the hydro-electric aluminium works of Lochaber in the foreground.

[The North British Aluminium Co. Ltd.]

Another recent and great development is the production of power utilizing the water flowing from Loch Eriicht and Loch Rannoch to the Tummel tributary of the Tay ; this power is transmitted by the "Grid" system to the towns of the east coast of Scotland.

Three main railway-routes cross the Grampian Highlands : to Inverness and other parts of the Moray coastlands ; to Fort William and the middle section of Glen More ; and to the southern end of Glen More and Oban, a tourist centre on the Firth of Lorne. No railway traverses the whole length of Glen More, and the main use of the Caledonian Canal which connects its waterways and the sea is the conveyance of tourists.

The population of the Grampian Highlands is necessarily very small. The crofters' holdings, which support most of the people except in the tourist centres, are limited by physical conditions, and the natural increase of population must be met by emigration ; indeed, with the hardships and difficulties of the crofters' lives and the possibilities and attractions of more favoured regions elsewhere, the population shows a marked decrease.

The North-west Highlands.—Along the north-west coast, land and sea seem almost inextricably intermingled ; sea lochs lead tidal waters far inland, while peninsulas and islands project settlements oceanwards. Moreover, in many ways even the Outer Hebrides resemble districts on the landward side of the Minch. For these reasons the islands are scarcely to be distinguished from the mainland as a separate natural region. Yet the coastal areas and the islands together have characteristics not found in the interior, and the latter country will be first considered.

The Inland Plateau is broadly comparable with the Grampian Highlands west of the Garry-Tay line, and instead of a fresh description, it may suffice to indicate the main differences between the two regions. Reference to the maps of climatic conditions will show that in the North-west Highlands the summer temperatures are lower and cultivation is therefore still more handicapped. Wooded areas are smaller, and the expanses of moors and bogs are greater.

The bed-rock is mainly gneiss, and granite outcrops are small ; the plateau level is lower and its dissection has been effected by a considerable number of streams running in a direction

often west to east in the southern part and north-west to south-east farther north.

In consequence of these trends in the valleys, communications have a general west to east direction ; of the two railways which cross the region one runs from Fort William west to Arisaig and then to Mallaig, whence boats go to the more southerly islands of the Hebrides. The other goes from Dingwall to Kyle of Lochalsh, at the head of the Inner Sound between Skye and the mainland, and thence a daily mail steamer keeps up communications with Stornoway, the chief town of the Outer Hebrides.

The valleys of the interior are often occupied by many long lochs and by stretches of desolate bogland, while the intervening moors are generally of the " wet " type ; arable land is very limited and grazing land is very poor. The lack of resources and the remoteness of situation make this region the least populous of the larger areas of the British Isles ; from this point of view, as from others, it comes nearest to justifying the term " a barren land."

The Coasts and the Islands present some features of special interest. The gneisses and schists of the interior end rather abruptly along a line which is shown on the geological map as running from Loch Eriboll, on the north coast about 15 miles west of Cape Wrath, to the Sound of Sleat on the south-east side of Skye. Over much of this distance they tower above a low, hummocky, coastal platform worn down from another mass of gneiss, known as Lewisian gneiss because it also builds the island of Lewis-Harris in the Outer Hebrides. The inland gneiss has not only been upraised but also thrust north-westward for miles over that of the coastal area.

The junction between the two masses is, however, largely masked by an intervening belt of thick masses of pre-Palæozoic sedimentary rock, known as Torridonian sandstone, because of its occurrence in the neighbourhood of Loch Torridon. These grits and sandstones are generally red, but have bands of lighter and darker material, and they have weathered to extraordinary pyramidal shapes ; thus in form and colour they present striking contrasts to the low-lying, often greyish Lewisian gneiss upon which they stand.

In addition, therefore, to the alternation of hills and valleys, promontories and lochs, this coast shows the great sugar-loaf

peaks of Suilven and other mountains, rising precipitously above a low, irregularly worn platform studded with pools and intersected by channels, the whole backed by the dissected edge of the inland plateau.

Still another complication in the structure is the existence of enormous sheets of lava, poured out through fissures upon the older rocks during the "Alpine" dislocations. These eruptions occurred along the western shore, and the resultant igneous masses are shown on the geological map as forming the greater part of Skye, the tip of the Ardnamurchan Peninsula (the most westerly point of the mainland), the island of Mull and smaller areas. This structure is responsible also for the tiny island of Staffa, near Mull, with its famous colonnades of basalt columns, formed by the lava contracting as it cooled. Here, too, is Fingal's Cave, worn by the waves from lava of many shades of red and brown and varied by the colours of the seaweed and lichens on the walls, while from the roof hang stalactites of limestone deposited by water which filters through cracks in the rock.

All the coastal region, indeed, has a diversity of form and colour, often enhanced by the play of light as the sunshine pierces the mists or is reflected by spray from the huge waves which break upon the cliff-edged shores.

The Outer Hebrides, which go under the inclusive name of Long Island, exhibit less variety. Although in the southern portion of the largest island, Lewis-Harris, the gneiss rises to considerable heights, the general structure is that of a glaciated peneplain; much of it is submerged or reduced to an intricate series of lochs, and the remaining parts are worn back by the sea, sometimes to low shores and sometimes to higher cliffs. Moors cover much of the surface, and bogs and many small lakes and pools occupy the hollows separated by rounded bosses of almost bare grey rock. Sea-birds nest in great numbers, and the fish of the surrounding seas form a valuable resource, but natural pastures are small and stony and of little value.

The crofters of the coastal districts, both on the mainland and on the islands, cultivate small patches of land, often on raised beaches, growing potatoes and oats for their own use and fodder to eke out the pasturage for their few sheep and cattle. Some of the cattle are sent away, and though the wool of the sheep is spun in small factories, it is woven in the cottages and sometimes coloured with dyes obtained from lichens, bracken and heather.

The weaving and dyeing of the wool, the care of the animals and even the tillage of the crofts are the work of the women while their men-folk are away at the fishing. Stornoway is the chief centre of the herring and other fisheries on the islands, but for export the catch is mostly landed at the railway termini along the west coast. Yet the exchange of goods between the crofters and the people of other regions is small, and they have to depend to a large extent on the scanty produce of their own lands and waters.

Life is hard in the tiny settlements, and although along the coast communications are better than in some of the valleys of the interior, the outer isles suffer particularly from isolation. In the whole of the North-western Highlands the population is only about 100,000 persons, and since the beginning of the present century it has declined by almost one-quarter.

The Shetland Islands.—If the Orkneys are an exclave of the North-eastern Lowlands, the Shetland group may be regarded as a detached fragment of the North-western Highlands, for although much of the area is low, they are mainly composed of similar metamorphic schists and gneiss. Their edges have been worn into cliffs, sometimes precipitous, and there are deep fiord-like inlets known as voes, while the interior generally presents a bleak and dreary appearance.

In spite of their northerly situation in Latitude 60° , the prevailing south-westerly winds and the Gulf Stream Drift give them a relatively mild if stormy winter and a cool summer, the mean temperatures for January and July being about 38° and 53° Fahr. respectively; at mid-summer the period of light extends so long that print is legible at midnight.

The crofters live in much the same way as those of the Hebrides, but grow few potatoes, giving most of their small patches of cultivation to oats and root-crops. They keep both cattle and sheep, and Shetland wool is as well known as the small shaggy-haired Shetland ponies. Fishing is, of course, the other occupation of the islanders, and Lerwick is the port and chief fishing centre. Of about one hundred islands, some thirty are now inhabited; the population, which is about the same as that of the much smaller Orkneys, is decreasing relatively rapidly. The situation of the Shetlands suggests that it is a stepping-stone between Norway and Scotland, and the history of its conquest and settlement by the Norsemen bears out this

idea ; one of the few contrasts between these islands and those of North-western Scotland is the absence of Gaelic, and the presence of many Norse words and phrases, in the speech of the people of the Shetlands.

Reviewing the facts stated in this chapter, it will be seen that there are sufficiently close similarities between the tract-groups of the Grampian and North-western Highlands for them to form one sub-region, with characteristics distinguishing it from the North-eastern Lowlands on the east and Central Scotland on the south. It may be noted that there is considerable uniformity in the geographical conditions over the Highlands as a whole, and similarly over the North-eastern Lowlands, and that these sub-regions are therefore of the simple type. On the contrary, the complicated geological structure of Central Scotland has caused great variety, and even contrast, in the geography ; this sub-region is clearly of the composite type.

The Population of Scotland.—The whole country has a population of close upon five million persons supported upon an area of about 30,000 square miles ; the average density of population is therefore about 170 persons to the square mile. The total number is not now changing rapidly, for a decrease over the greater part of the country is roughly balanced by an increase in the lowlands of the better endowed central region ; consequently the disparities in the densities of population in the various areas, already very marked, are becoming greater.

Central Scotland has always been by far the most important region. Northern Scotland, except along the east coast, has remained with relatively few inhabitants, while the Scottish Uplands have played the part of a barrier between the populous midland area and England. Central Scotland, therefore, was a region which enabled a people to develop, remote from and different from those of Southern Britain, and able for centuries to remain politically distinct. Yet it was open on the east to invasions, and as the result of these the English language long ago superseded Scottish Gaelic.

This language has survived only in the Highlands. In the North-west Highlands about half of the population can still speak Gaelic, but even in that remote region the proportion of the Gaelic-speaking people is decreasing and those who depend entirely upon their ancient language are now few in number.

CHAPTER XV

IRELAND

Relief and Structure.—The hackneyed statement that the form of Ireland is like that of a saucer with a flat bottom and an upturned rim is far from the truth, but it may be recalled if only to point out that if the flat bottom represents the Central Plain and the upturned rim the marginal uplands, a saucer actually shaped like Ireland would be very inefficient, for it is an important characteristic of the Central Plain that in several parts it extends through the marginal uplands and reaches the sea. Indeed, near the middle of the region, it stands at about 250 feet above sea-level, and thence sinks gently eastward where it is drained by the Liffey and Boyne rivers to the Irish Sea, and westward where it is drained by the Shannon to the Atlantic Ocean. Moreover, the westernmost part of the plain extends to the Atlantic at four places where subsidences have allowed the ocean to penetrate through the marginal uplands, viz. at the heads of Galway Bay, Clew Bay, Killala Bay and Sligo Bay.

Almost everywhere, this wide lowland is formed of more or less horizontal sheets of Carboniferous limestone (see the geological map); the occurrence of this limestone over great areas almost undisturbed and little above sea-level constitutes one of the main characteristics of the geography of Ireland. While in England the Carboniferous limestone is upraised and its elevation permits water to drain down through it leaving a typically dry surface, in Ireland the great areas which lie relatively little above sea-level tend to become water-logged, and their usual heavy cover of boulder clay is a further hindrance to drainage; consequently these flat limestone areas are typically wet and often the site of lakes and peat-bogs.

Although at present the slow-moving waters have little effect in eroding the Central Plain, there is abundant evidence that during past geological periods it has been worn down from the state of a plateau, and two pieces of evidence are closely related to important facts of the present day. On the margins of the lowland there still remain fragments of the plateau where above the

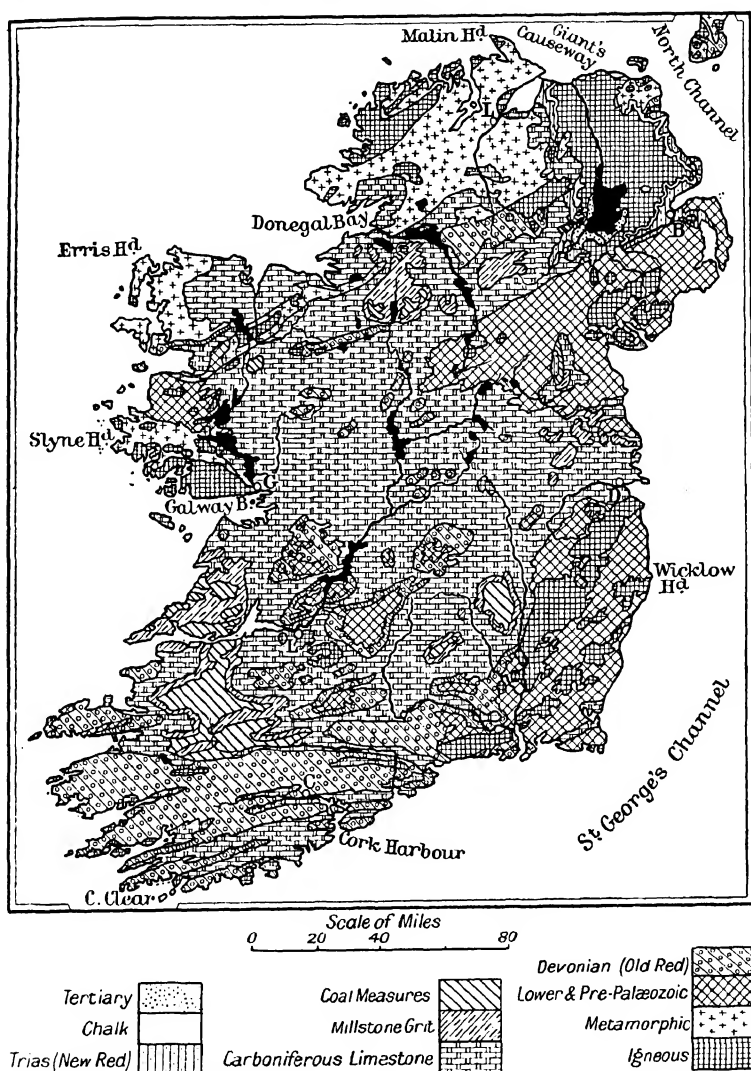


FIG. 54.—GEOLOGY OF IRELAND.

Carboniferous limestone are found sheets of Millstone grit and above these are remains of Coal Measures. This is the case (as can be seen on the geological map) just beyond the northern limit of the plain around Lough Allen near the headwaters of the Shannon, and again on its southern margin west of Carlow, by

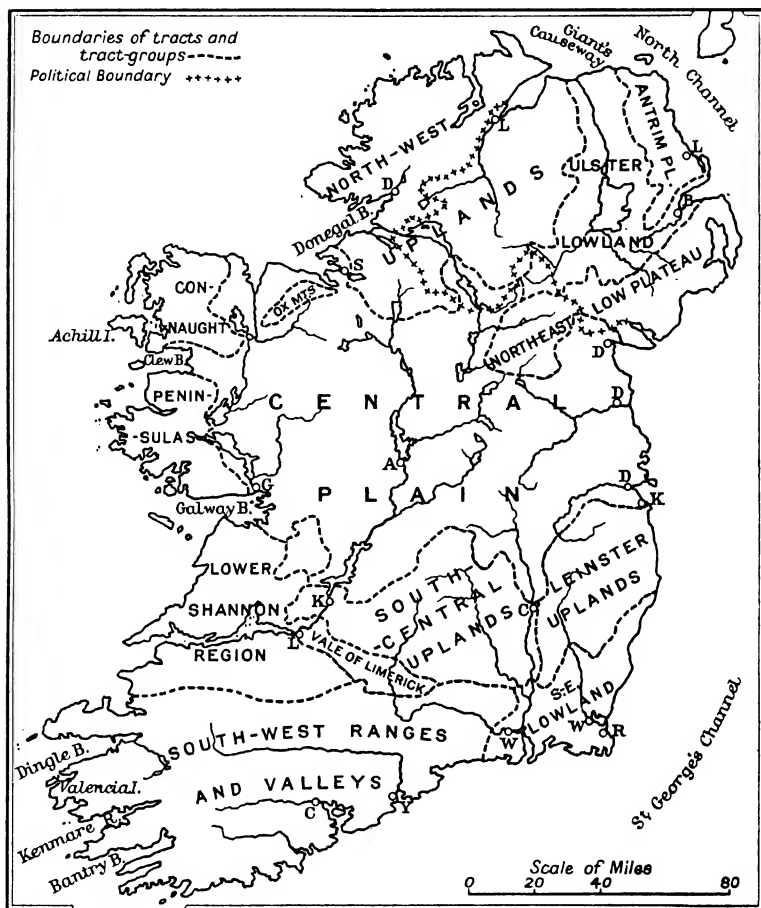


FIG. 55.—REGIONS OF IRELAND.

the River Barrow. As a general rule, in Ireland the remains of the Coal Measures do not include workable seams of coal, but the fragment left west of Carlow contains some anthracite.

Another fact pointing to the previous existence of a plateau in Central Ireland is the gorge of the Shannon below Killaloe at the southern end of Lough Derg. A relief map shows that here the Shannon has cut a narrow valley between the Slieve Bernagh¹ on the west and the Arra Mountains on the east, and the geological map shows these to be parts of one great mass of resistant

¹ Slieve = mountain.

lower Palæozoic rock. The cutting must have been done when the river flowed over a plateau at least as high as the present mountain masses, i.e. nearly 2,000 feet above sea-level. (The case is very similar to that of the gorge of the Wye bisecting the Forest of Dean.) The rapid fall of the river in the gorge below Killaloe is utilized for water-power, and it may be observed that the denudation of the plateau has here given a source of mechanical power to be offset against the loss occasioned by the widespread removal of the Coal Measures.

On both sides of the Severn estuary below Limerick, the various strata of the Carboniferous system are piled one above the other to considerable heights, but still in fairly horizontal arrangement. In the rest of Ireland, however, that is, in the north, the west and the south, the rocks have been greatly disturbed in the Caledonian and Hercynian earth movements, and the present relief is mainly that of dissected uplands showing a graining along directions associated with these disturbances. These trends are marked in the map in Fig. 58, showing the structural relations of Ireland with Great Britain and the continent of Europe.

In the south-west there is a marked series of ranges and valleys with a trend from east to west, corresponding to that of South Wales, and turning to the south of west as it is "drowned" beneath the Atlantic waters. This region may be called the "South-west Ranges and Valleys"; in general, the ranges represent upfolds of the Armorican mountain system, still preserved because they are formed of resistant Old Red sandstones, while the valleys are downfolds in which the rivers have cut their way through less resistant strata of Carboniferous age and varied composition. The ranges are frequently broad moorlands, and rise in the east in the Galtee Mountains to 3,000 feet and in the neighbouring Knockmealdown Mountains to 2,600 feet. In the west the ranges are even higher, where they stand up between the drowned valleys, or rias, of Dingle Bay, Kenmare River and Bantry Bay; on the north side of Dingle Bay, Brandon Hill reaches well over 3,000 feet, and on the south side, Carrantuohill in Macgillycuddy's Reeks is more than 3,400 feet above the sea. Immediately to the east of Macgillycuddy's Reeks a band of the Carboniferous rocks has been worn down to a deep hollow, now partly occupied by the waters of the Lakes of Killarney.

The long reaches of the rivers, running from west to east in the cases of the Blackwater and the Lee, are clearly longitudinal and subsequent, and they are interrupted by sharp, rectangular turns to the south, e.g. where the Blackwater turns southward through a moorland ridge to reach the sea at Youghal Harbour, and where the Lee, below Cork, sends its waters southward through the broader drowned valley of Cork Harbour. The shorter, north-to-south reaches of the streams represent parts of the earlier, consequent rivers, which flowed southward across a plateau from which the present relief has been developed. Even the rivers to the north of this region show the previous existence of the same plateau-structure where the Barrow, Nore and Suir still have north-to-south reaches. Where the Suir, however, enters the "Ranges and Valleys" region it is diverted eastward towards Waterford, before entering the drowned, lower valley of the Barrow, known as Waterford Harbour.

On the east side of the Barrow, the grain of the land is quite different, for here the Caledonian direction, south-west to north-east, is evident. In the counties of Wicklow and Wexford one may see in the Leinster Uplands a counterpart to Central Wales, and the subsidence of the land beneath the Irish Sea appears to have broken the continuity of what was once a single land-mass. The nucleus of the Wicklow Mountains consists of a huge bar of granite, shown in the geological map as the belt of igneous rock stretching from the south of Dublin Bay south-westward to the valley of the Barrow; it forms a broad, open upland, between 2,000 and 3,000 feet above sea-level, and on it gather streams which have cut deep and narrow valleys in the Palæozoic rocks bordering it on both sides.

South of the Wicklow Mountains, other Palæozoic and igneous rocks show the same Caledonian trend, but they represent an old peneplain which has here been raised relatively little above sea-level, in the same way as across St. George's Channel the rocks of Pembrokeshire have suffered little uplift. The drowned valleys of this South-east Lowland region give broad but rather shallow inlets, and consequently the ferry service from Fishguard in Pembroke does not enter Wexford Harbour, but runs to Rosslare, where a deep-water artificial harbour has been constructed.

West of the valley of the Barrow, this river and its tributaries drain the greater part of an upland region which may be called

the South-central Uplands. It is of varied structure, composed of rocks which show the Caledonian graining, and are highest in the north-west of the region ; here are the Slieve Bloom, largely formed of resistant Old Red sandstones, and continuing them to the south-west are other ranges, including the Silvermine Mountains of the same strata. Adjoining the Silvermine Mountains on the west is the upland through which the Shannon has cut the Killaloe gorge, and a few miles to the west of Lough Derg, other resistant rocks rise through the limestone to form the exclave of the Slieve Aughty.

In Northern Ireland the Caledonian trend is again visible, and in several respects the structures may be regarded as continuations of those of Scotland. If the line of the Scottish Uplands is prolonged across the North Channel into the Irish county of Down and thence south-westward to the head-stream area of the River Erne, it will traverse a region which has some similarity to the Scottish Uplands. The Rhinns peninsula of Galloway has a counterpart in the Ards peninsula of County Down, almost cut off from the mainland by Belfast Lough and Strangford Lough. Inland from the North Channel, both the Scottish and the Irish regions rise gradually, and the irregular granite mass of the Mourne Mountains in the south of County Down may be compared with the Kells Range in Galloway. Farther inland in Ireland, however, the region of hard rock has not been upraised as in the Scottish Uplands, but forms a low plateau, with an almost level surface and with ill-developed drainage to the surrounding lowlands. As a whole, this region may be called the North-east Low Plateau.

The North-west Uplands of Ireland correspond in some degree with the Highlands of Scotland. The bed-rock is mainly igneous and metamorphic ; folding in the Caledonian disturbances and later peneplanation, fracturing, uplifts and subsidences, have resulted in the production of a plateau region which has been greatly dissected and its margins drowned, while the ridges, valleys and inlets show in many instances the south-west to north-east trend. This direction is clearly visible in the inner part of Donegal Bay, near the town of Donegal, and almost back-to-back with this is the valley of the Foyle, near the city of Londonderry, and the drowned hollow of Lough Foyle.

The heights, however, are by no means as great in the North-west Uplands of Ireland as in the Scottish Highlands, for they

reach little over 2,000 feet ; yet the cliffs on the north side of Donegal Bay are the highest in the British Isles, for here the tremendous power of the Atlantic storm waves has cut back the quartzite mass of the Slieve League to form an almost sheer precipice of nearly 2,000 feet.

South of Sligo Bay, the Ox Mountains may be regarded as an exclave of the North-west Uplands, for they are composed of similar igneous and metamorphic rock rising through the limestone of this part of the great Central Plain ; the Ox Mountains, moreover, form as it were a stepping-stone across the ill-drained plain to the two upland areas of Connaught (or Connacht). These Connaught Uplands project into the Atlantic the last fragments of the Caledonian structures, which indeed stretch from Norway, through Scotland and Northern Ireland, till they end in these western peninsulas, breaking down into innumerable capes and islands before disappearing beneath the waters of the ocean.

In Scotland, between the Highlands and Uplands the rift valley is filled with younger rocks, and somewhat similarly in Ireland, between the North-west Uplands and the North-east Low Plateau there is a structural hollow in which younger rocks are found. As in Scotland, these include Old Red sandstones and Carboniferous strata, though in Ireland the latter are not coal-bearing to any significant degree. But in Ireland there are still more recent layers ; among these are New Red sands and marls on the coast of the North Channel, around Belfast Lough and in the valley of the Lagan above Belfast, and in the lowlands drained by the Blackwater to Lough Neagh. Also a sheet of chalk crops out between these New Red lands and the rocks which form the Antrim Plateau.

The Antrim Plateau breaks the continuity of the lowlands around it, because of the outpouring of great masses of basalt during the Alpine earth movements. Enormous sheets of lava were extruded above the chalk, completely hiding it except on the margins, till they formed a great plateau which even yet reaches a height of over 1,800 feet. Farther westward the sheets are lower, and form the broad valley in which are Lough Neagh and the lower River Bann.

These lava outpourings are doubtless related to those of Skye and Mull farther north (see Fig. 58), and the colonnades of Staffa are matched by the "Organ Pipes" on the north coast of Antrim

and the neighbouring "Giants' Causeway," where the columns constitute great terraces representing the successive sheets of lava.

Fracture of the rocks was a necessary condition for the outpouring of such masses of basalt, and faulting led to the subsidence of the sheets at the south-western corner of the area ; in the hollow thus produced, the water brought down by the upper Bann and the Blackwater has accumulated to form Lough Neagh, the largest lake of the British Isles.

As regards the structure of Ireland, it may therefore be said that in the north some of the main features of the build of Scotland are prolonged southward and south-westward ; in the south the structures of Wales extend eastward ; in the centre is an area peculiar to Ireland inasmuch as the strata of the great plain have remained relatively little affected by disturbances which bent and dislocated similar rocks in Great Britain.

Like most of the British Isles, Ireland was glaciated, and almost everywhere glacial deposits have modified the surface conditions. The separation of Ireland from Great Britain is of very recent date, according to geologists' reckoning, and was completed only by the subsidence in the Irish Sea region in post-glacial times.

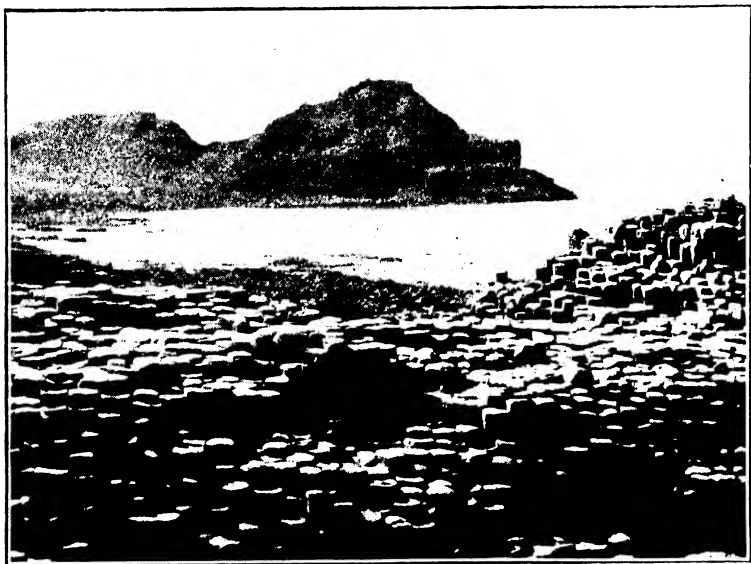
Climate and Vegetation.—The westward prolongation of the British structures into the Atlantic region and the subsidences which have allowed the oceanic waters completely to surround Ireland have given it an extraordinarily maritime climate. This is shown, of course, most markedly in the south-west, where the meteorological station on Valencia Island, at the south side of Dingle Bay, has provided the records from which the graphs in Fig. 16 have been drawn.

The temperatures in winter are relatively high and very similar to those of Falmouth, only the slightly lower absolute minima on Valencia Island suggesting the higher latitude, while in summer the temperatures are in general rather lower than those of the Devonian Peninsula. Comparing summer with winter, it appears that conditions are more equable here than anywhere else in the British Isles.

The east of the country experiences rather greater variations, as may be seen from the isothermal maps in an atlas ; in July the south-east has a mean sea-level temperature of over 60° Fahr.,

and in January the north-east has a mean sea-level temperature somewhat below 40° Fahr. Even this difference of a little more than 20° Fahr. between the mid-summer and mid-winter temperatures, however, must be regarded as indicative of more equable climatic conditions than those common in Great Britain, and in particular than those of the English Lowland.

The rainfall of Ireland also shows the influence of the oceanic situation, for the greater part of the island has an annual total of



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FIG. 56. THE GIANTS' CAUSEWAY, CO. ANTRIM.

In the foreground are the hexagonal basaltic columns of the Causeway, and in the background is a part of the eroded lava plateau.

over 40 inches, and most of the south-west has over 60 inches ; there are not, however, the very great amounts characteristic of the highest districts of the west of Great Britain. The conditions in the rainy south-west are shown in the graph for Valencia Island ; the relatively heavy rainfall, even as compared with Falmouth, during the later winter and earlier spring months should be observed, and the relatively small number of days without rain in the winter is noteworthy. Further, the contrast in the number of days of snow at Valencia with that at Aberdeen bears striking witness to the mildness of the climate.

The combination of abundant rainfall with a growing period which lasts throughout the year and the extreme rarity of frosts, explains the characteristics of the vegetation. The "Emerald Isle" is indeed commonly green with the rich pastures on the drier soils; on the wetter soils an accumulation of marshy plants has resulted in the development of bogs. In the south-west of Ireland, as in the Devonian Peninsula, "sub-tropical" plants, including the arbutus, are to be found. The small proportion of grain crops, and their almost complete limitation to oats, is an indication of how agriculture adapts itself to the moist climate. Local variations in the type of farming, however, are considerable, and will be brought out in the following brief description of the tracts and tract-groups of the island.

Constituent Regions of Ireland. —*The Central Plain.*— Perhaps the most striking characteristic of this tract-group is the ill-drained condition of wide areas. The limestone is normally water-logged, and surface drainage is often hindered by deposits of boulder clay or by other glacial material; indeed, in some places this has dammed up the streams to form lakes, as in the case of the group of small lakes which occupy almost the centre of the country east of the Shannon. In many other cases the lakes are to be regarded as expansions of the rivers where the slowly flowing waters, made acid by the peaty material through which they have passed, have dissolved away the limestone and so created the shallow hollows of the lake-basins.

The irregular shape of many of the lakes is accentuated by the numerous islands which rise above their waters; this is to be seen in Lough Ree, where the Shannon is partially dammed by a low glacial ridge crossing the valley at Athlone. It is to be seen also, and in a still more extraordinary manner, in the northern extension of the Central Plain between the North-east Low Plateau and the North-west Uplands; here the river Erne flows northwards through a perfect entanglement of land and water, of which the Upper Lough Erne forms a part, while on the margins of the water often occur sedge-grown swamps.

In the extreme west of the lowland, Lough Mask has underground drainage to Lough Corrib, and in the adjoining plains are many hollows which are more or less dry in summer but in winter become lakes.

Great bogs are another characteristic of the region, in-

dicative of the fact that the amount of the precipitation has exceeded the loss by drainage and evaporation ; the resultant wetness has led to the growth of marsh vegetation which has accumulated, particularly in hollows probably once the sites of lakes, to form bogs. These are very common west of the Shannon, but the most extensive is the Bog of Allen, between the Liffey and the Shannon. This area has now been in part reclaimed ; peat has been dug out for fuel, and the new surface has been levelled, drained and planted with potatoes or rye.

Frequently the dreary, brown bog-lands are relieved by green rises, sometimes appearing as broad gentle slopes and sometimes as steeper, grass-grown ramparts ; these are the innumerable eskers which lie in great curves and festoons, generally in an east-west direction, across the country, and provide not only pastures but cultivable lands and firm foundations for roads.

As a general rule, the farming is based upon the use of permanent grass-lands for raising cattle, for the sale of stock to England is normally the chief source of revenue ; the growing of potatoes and oats as food both for men and animals, and of root-crops for the cattle, are the chief uses of the relatively small proportion of arable land. This proportion is rather greater in the east, where the rainfall is less and the summer temperatures rather higher, and where also the land is generally better drained ; in this part, the largest numbers of cattle are reared, as in the counties of Meath, Westmeath and Kildare. Pigs and poultry are everywhere kept, and horse-breeding is a common occupation.

The extensions of the Central Plain to the sea afford important route-ways and provide the sites of ports, which are of different degrees of importance according to their position. Naturally, the eastern gateway leading to Great Britain and the Continent is by far the most used, and in the sheltered Dublin Bay, the first point of entry from the south, is Dublin, the chief port and the capital of the Irish Free State. Into it come food-stuffs, manufactured foods and coal, the chief imports into Ireland, and in normal times when trade has not been interrupted by political difficulties, from it are sent live cattle, sheep and pigs, dairy produce, bacon and ham, which form the bulk of the Irish exports.

The outpost previously known as Kingstown, now called

Dún Laoghaire, takes some of the traffic, especially the passenger traffic; on the inland side, the trade from Dublin is carried on mainly by road and railway, though a small proportion uses the Grand Canal which leads to the Shannon and Barrow river systems.

Farther north in the lowland entry is the small port of Drogheda at the mouth of the Boyne, and at the northern end is the rather more important Dundalk, in a well-sheltered bay.

On the Atlantic coast, only Galway has much significance; it might provide a quick route for the transatlantic passenger and mail-traffic, with railway connexion across Ireland, and thence a train-ferry to Great Britain, but ocean liners would find Galway as a port of call off their routes either to the north or to the south of Ireland, and as a terminal port it is obviously remote from the great areas of production or consumption of goods.

As the main port of entry to the country, Dublin occupies in Ireland a position analogous to that of London in England, with communications radiating inland in all directions. It has accordingly become the seat of the Government and centre of commercial, industrial and professional activities in the Irish Free State, although as an industrial city it has been surpassed by Belfast in Northern Ireland. The inhabitants of the conurbation number more than 400,000, and the country in its immediate neighbourhood is the only part of the Irish Free State that can be regarded as densely populated. Beyond Dublin, no settlement in the Central Plain has developed into more than a small country market-town.

The Leinster Uplands.—The backbone of this tract is the belt of granite which forms the Wicklow Mountains and is continued south-westward where it constitutes the high water-parting adopted as the boundary between the counties of Carlow and Wexford. The granitic centre of the Wicklow Mountains is largely barren moorland, and on the better pastured areas sheep are fed. The margins, however, are diversified by steep-sided and wooded glens whose streams, golden-brown from the peat-bogs above, descend in cascades and waterfalls; among these glens the Vale of Avoca is famous for its beauty. The two main upland areas are separated by the valley, cut by the River Slaney, which leads across from the Central Plain to the South-east Lowland.

The South-east Lowland.—On this ancient peneplain have

developed relatively fertile soils, and the summer warmth and lower rainfall have made this region one of the most cultivated parts of Ireland, remarkable particularly in the higher proportion of the land given to the growing of barley, used in the brewing and distilling industry. Oats are also obtained and a small amount of wheat, as well as the fodder crops and potatoes grown in all the lowland parts of the country.

To this lowland region the rivers have cut their way from the three adjoining uplands. The Slaney leads to the depression of Wexford Harbour, while the combined waters of the Barrow, Nore and Suir make their way to Waterford Harbour; little trade, however, is done by the town of Waterford, which is situated on the Suir above its junction with the Barrow.

The South-Central Uplands. In this composite tract-group the higher areas of more resistant rock have different characteristics from those of the lower areas mainly formed of Carboniferous limestone. The former are moorlands, utilized only as rough grazing land, the highest bearing patches of bog, from which this region is otherwise unusually free. The lower lands are in general fertile, for glaciation has resulted in a mixture of soils derived from the higher areas as well as from the underlying limestone. In the lee of the western and south-western mountains, oats and barley and fodder-crops are grown, though the greater part of the land is under grass. The small production of the Carlow, or Leinster, coalfield has not given rise to industry, but the cutting of the Shannon through the belt of resistant rock below Killaloe is of great significance.

The virtual absence of coal from Ireland, and the destruction of the forests which has left but little timber, have made the people to an unusual extent dependent upon the use of peat as fuel, but the water-power of the Shannon has recently enabled electricity to become an important source of light, heat and mechanical power. Lough Derg, with its level raised by a dam, gives a great and steady flow of water, and from the power station near Limerick the "grid" distributes the current to all parts of the Irish Free State.

The Vale of Limerick.—Similar to the fertile river valleys of the preceding region is the relatively broad hollow called the Vale of Limerick, and sometimes known as the "Golden Vale," or, more correctly, the "Golden Vein." Here, again, are mixed soils due in part to glacial influence. While in general the

farming is like that of the neighbouring lowlands, it is more concerned, especially near Limerick, with the keeping of dairy cattle. The tract forms a corridor between south-eastern and western Ireland, avoiding the corrugated south-western region; it includes several small market-towns and at its western extremity is Limerick.

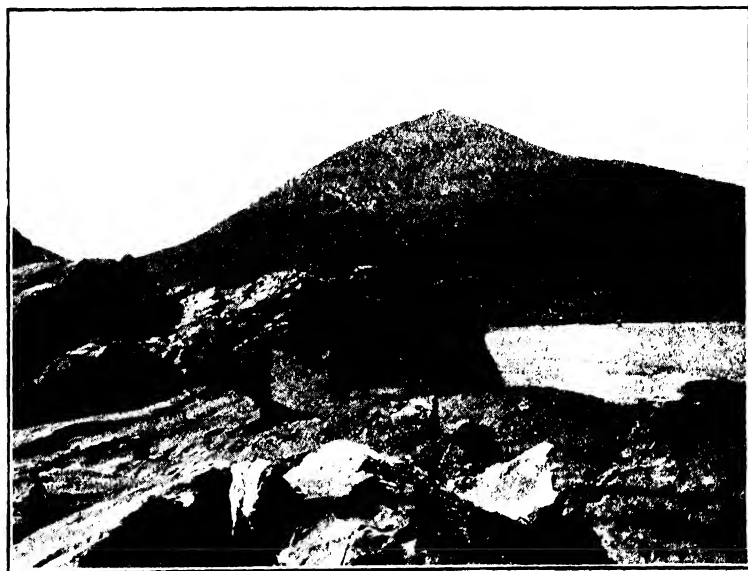
Although Limerick is the port at the mouth of the greatest river of Ireland, it has but little commerce and has remained but a small town. It shares the handicap of position which was pointed out in connexion with Galway, and the channel in the Shannon estuary is very shallow except at high tide. Also the products of Central Ireland, particularly the live-stock, are sent by the more direct eastward routes to their markets. Consequently, the canal system which links the Shannon to the eastern waterways is much more important than that which avoids the falls and links the navigable part of the river with its estuary. The trade of Limerick is therefore restricted, and consists mainly of the import of coal and other goods for local use, including grain which is milled at the port.

The South-west Ranges and Valleys.—As might be expected, there is a marked contrast between the relatively barren moorlands of the ranges, useful mainly as rough pasture for small numbers of sheep, and with areas of bog and outcrops of almost bare rock, and the fertile valleys, in which rather heavy soils have accumulated, giving opportunity for the growing of oats and potatoes and the development of rich pastures. On such lands is carried on much rearing of cattle, partly for beef but still more for dairy purposes.

The wide valleys of the east of the region, those of the Suir, Blackwater, Lee and Bandon, in the counties of Waterford and Cork, constitute one of the most important areas in the British Isles for dairy produce; hence from Cork, in the centre of the region, butter and live animals are exported, as well as large numbers of pigs, which here, as is commonly the case, are kept in association with the dairy industry. Cork is the second port of the Irish Free State, for it draws trade even from the neighbourhood of Limerick and the Lower Shannon region, a direct railway route taking advantage of a wide "wind-gap" through the ranges south of Limerick. Motor-car works have been established at Cork, where materials can be imported and power obtained from the station near Limerick.

The abundant rainfall and the exceptionally mild climate of this region are obvious aids to the cattle-keeping in the valleys, but in the western part which drains to the Atlantic, the mountain masses are wider and the drowning of the lower parts of the valley has left but small lowland areas. Consequently, in the westernmost county of Kerry, there is much less production.

This country is, however, one of the most beautiful parts of Britain. The mountains often descend steeply to the indented



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FIG. 57.- VIEW ON ACHILL ISLAND, CO. MAYO.

The view shows an almost barren coast, from which the conical-shaped Slieve More (Great Mountain) rises over 2,000 feet above the sea.

coasts, frequently heather-clad, with mosses and ferns in the crevices of the rocks, and in the sheltered valleys myrtles, rhododendrons, fuchsias and the arbutus tree, and even palms and bamboos. In the less exposed interior, as around the famous lakes of Killarney, there are woodlands, and in the rivers and lakes salmon and trout fishing add to the attractiveness of the country to holiday-makers.

The Lower Shannon Region.—Here again is found a contrast between lowland and upland, but the region is often of tabular, instead of upfolded, structure. The uplands are therefore com-

monly plateau-like, recalling the higher parts of the Pennines in their composition and surface-form, but often wetter and with extensive areas of bog. Other parts, where the limestone is not covered by bogs or impermeable clay, are distinctly karst-like, with the streams appearing only intermittently.

Yet near the Shannon, and particularly on the south side of the estuary, the lowlands have a pastoral industry almost comparable with that of the adjoining Vale of Limerick.

The Connaught Peninsulas.—The worn-down mountain masses of this twin-region alternate with valleys and with broader lowland areas into which the sea penetrates in most intricate fashion. Off the northern of the two peninsulas, Achill Island is separated by so narrow a strait that it is connected with the mainland by a bridge. The highlands are almost barren, but their lower slopes may be pastured with sheep, for this region is exceptional in Ireland in having very few cattle but many sheep, particularly in Connemara, in the southern peninsula. The lowlands are often occupied by bogs, and Mayo, which includes both the northern peninsula and the lowland adjoining it on the east, has the largest area of bog-land of any county of Ireland. Cultivable lands are rare, and the farms are extremely small, mere patches on which potatoes are the main crop, sheltered from the destructively strong winds by high stone walls. Seaweed (kelp) is used as manure, and fishing ekes out the scanty living of the few inhabitants. From this region there is an annual migration of both men and women to western England and Scotland to help in the planting and digging of potatoes and the harvesting of hay and crops.

The North-west Uplands.—The county of Donegal is a peninsula rather like those of Connaught, and although it has a less area of bog-land than Mayo, it has the distinction or misfortune of possessing the greatest area of mountainous waste-land in Ireland. In many ways, this north-western peninsula of Ireland resembles the north-western highlands of Scotland, though a rather milder and less rainy climate and wider areas of lowland make possible a larger production of oats and potatoes, the keeping of more sheep and cattle, and consequently a larger population.

The lowlands near the mouth of the River Foyle and on the southern shores of Lough Foyle are relatively fertile, and here is situated Londonderry, or Derry, of historical fame and now a

city of moderate size. This eastern section of the region is part of "Northern Ireland," which is politically united to Great Britain, and it comes also within the area in which there has been industrial development, including shipbuilding and the manufacture of linen. Londonderry is the port which would naturally be the entry to all the north-western region of Ireland, but the political boundary has become a customs barrier, and Donegal is to a considerable extent excluded from the "hinterland" of Londonderry.

South-east of the hollow leading from Lough Foyle to Donegal Bay, the uplands rise to considerable heights, as in the Sperrin Mountains, and are poorly populated; the lower lands are farms, which are relatively large and prosperous compared with those of Donegal and Connaught. They depend upon the keeping of cattle and the growing of potatoes, root-crops and oats. In the south-west extension of the region towards Sligo, however, a large area in the valleys is occupied by lakes, for here the older rocks disappear beneath the Carboniferous limestone.

The North-east Low Plateau.—The older rocks appear again in the low plateau which extends from the coast of County Down south-westward almost to the centre of the country, and on this generally undulating country glacial deposits greatly influence surface conditions and the utilization of the land. Heavy soils of boulder clay are common, and from them rise the gentle slopes of drumlins which form good pasture and crop-land, while eskers are also commonly utilized for cultivation. The farming is again generally centred on the keeping of cattle, but on the lower lands of County Down near the North Channel the growing of oats assumes special importance, and on the slopes of the Mourne Mountains and the other upland areas sheep are fed in considerable numbers.

The Antrim Plateau.—This basaltic mass stands up from the sea almost like a wall, but rises more gently from the lowlands on the west till it forms broad uplands, heather-clad and of very little value except as sheep pastures. In the process of decomposition of the basalt, ores of iron and aluminium have resulted; but while the iron is no longer of significance, there are still alumina factories at Larne, where fuel can be imported and the product sent across the North Channel to the Scottish reducing plants.

The Ulster Lowlands.—Between the upland regions of north-

eastern Ireland are important lowlands of which a small part is drained by the River Lagan to Belfast Lough and the remainder by the River Bann and its tributaries. This region may be conveniently called the Ulster Lowlands, for it forms the most important area in Ulster, both from the point of view of productivity and also from that of the distribution of population. It has already been pointed out that the strata forming the region are various, and they have weathered to soils whose fertility has in general been increased by glacial mingling, though in some districts the lack of good draining, so characteristic of Ireland, is present. The wetness of the climate, however, is lessened by the position of this region in the lee of the western uplands, and on the whole the farming is productive. Large quantities of oats are grown, and cattle are kept for beef and also for dairying, a response to the demand of adjoining areas with industrial populations. The closest relationship between the agricultural and manufacturing interests of the region, however, is shown by the growing of flax. While this crop is obtained to some extent from the southern margins of the Ulster Lowlands, in or near the Lagan valley, the greatest amount comes from the basaltic soils north of Lough Neagh and the coastal districts near the mouth of the Bann.

The linen industry of Ulster began as a hand-craft; in early days this was widely spread in Ireland, but here an impetus was given by the introduction of better methods of growing and treating flax by Huguenot settlers in the Lagan valley. The industry developed through the stage of using water-power to that of steam-power, the coal having to be imported from Great Britain. For a time the work was carried on mainly in the interior of the region, but later it became largely concentrated in Belfast, where harbourage at the head of the Lough gave facilities for import of coal and export of manufactured goods. Yet there are still factories scattered over the lowland region, the greatest production outside Belfast being at Lurgan at the end of the Lagan valley. One factor tending to the localization of the linen industry in Ireland, in addition to the growth of flax, is said to be the equability of the climate which permits bleaching to be carried on throughout the year.

The other industry which has largely contributed to the growth of Belfast is shipbuilding, and in this case there seem no local factors to account for the development. Only a small

industry existed before the middle of the nineteenth century, when a Yorkshireman who had learnt his business on the Tyne, with the assistance of a German who had been trained in engineering in Manchester, took over some unsuccessful works. By the energy and skill of the workers in this firm, the shallows at the head of Belfast Lough were converted into a shipyard; coal, iron, steel and timber were imported, and after the success of the original enterprise, other firms contributed to the growth of one of the chief shipbuilding centres of Britain. It is an interesting question whether, in the long-run, the industry, at first based largely on personal factors and then aided by the construction of efficient plant, will be able to prevail against greater advantages of position enjoyed elsewhere, particularly in view of the general decline of British shipbuilding.

Besides the staple industries of linen and shipbuilding, Belfast has numerous smaller ones, and with the trade of its port, its University and its position as the seat of government of Northern Ireland, it has a population of over 400,000 persons.

The Population of Ireland.—Although there are considerable differences between the regions which constitute Ireland, these differences are not associated so clearly with particular parts of the country as to mark them out as distinct sub-regions, and the whole island may therefore be regarded as one sub-region of composite character. It comprises both upland and lowland areas, and apart from relatively small centres where industry and commerce are carried on, it is a pastoral country.

As such, it is not able to support a great population, and, indeed, many of its present inhabitants are living near the margin of subsistence. In the early part of the nineteenth century the population increased rapidly to over 8 million persons, but after the "Great Famine" in 1846 it decreased as rapidly, with much emigration to America, and the present population of about $4\frac{1}{4}$ millions is still becoming smaller. As the area of Ireland is 32,500 square miles, the average density of population is about 130 persons to the square mile.

Although Ireland is a geographical unit, it is divided politically. After more than a century of union with Great Britain, in 1922 the greater part of the country, i.e. the provinces of Leinster, Munster and Connaught, and the county of Donegal in Ulster, with a total population of about 3 million persons, became the Irish Free State with a constitution declaring it to

be "a co-equal member of the Community of Nations forming the British Commonwealth of Nations." In Ulster, however, where many of the people were descendants of settlers from Scotland and England, the six counties of Antrim, Armagh, Down, Fermanagh, Londonderry and Tyrone, with a population of about $1\frac{1}{4}$ million persons, remained associated with Great Britain as "Northern Ireland." This administers its own local affairs, but continues to send representatives to the Parliament at Westminster.

The constitution of the Irish Free State declares Irish to be the national language, but English is equally recognized as an official language. Irish Gaelic, sometimes known as Erse, is spoken by the majority of the people in few districts outside the poorly populated western margins of the country; even there it is rare to find those who cannot understand English. The number of Irish-speaking persons for long continued to decline, until the recent attempts to revive its use and to study and extend Gaelic literature.

A cultural distinction between the Irish Free State and Northern Ireland is the prevalence in the former of the Roman Catholic religion, which is there the faith of 90 per cent. of the people, while in Northern Ireland only about one-third of those who record their religion in the census returns belong to the Roman Catholic Church.

CHAPTER XVI

REGIONS AND PEOPLES OF BRITAIN

The Atlantic Margins of Britain.—In this concluding chapter we will first review the common characteristics of the sub-regions of the British Isles which are situated north and west of the English Lowland.

They have much in common as regards their relief and structure, for they are all characterized by considerable areas of upland or highland, although these are associated with lowlands of varying extent. Also, they are formed almost entirely of rocks of ancient date and resistant composition ; in the main, hard sandstones and limestones alternate with metamorphic and igneous rocks. Both the relief of the land and the composition of the strata depend on the fact that in this part of the earth's surface, there appear fragments of the old structures of Caledonian and Hercynian mountain-folding, while associated with the Atlantic subsidences were uplifts on the margins of the Continent. The contrast between these regions and the English Lowland, with its low relief and its recent and little disturbed sedimentary strata, may therefore be seen to be fundamentally due to their respective positions.

The effect of the position of the Uplands is obviously apparent in their climate, which is both more equable as regards temperature conditions and also more humid and rainy than that of the English Lowland. The Pennine tracts are the least oceanic in situation, but their elevation results in a considerably greater rainfall than that of the adjoining lowlands.

So important are the consequences of this oceanic position, that these northern and western sub-regions may be called the "Atlantic Margins of Britain."

Relief and climate combine to determine the agricultural possibilities and limitations of the Atlantic Margins ; the area of cultivable lowland is restricted, and only the eastern parts of the regions have the necessary summer warmth and dryness to allow the growth of cereals other than oats. On the other

hand, the abundant rainfall and the mildness of the winter aid the growing of grass; consequently, the farming is predominantly of the pastoral type, cattle being kept in considerable numbers on the lower areas and sheep on the uplands.

The geological structure of the Atlantic Margins has permitted the formation and preservation of coal only to a limited extent, viz. in South Wales and in Central Scotland. Hence, the mining and industrial developments which characterize large areas of the English Lowland have occurred to a much less degree in the north and west of Britain. These regions, too, are more remote from the Continent of Europe, and commerce is therefore not encouraged.

Because of these limitations in the natural resources and opportunities of the Atlantic Margins, the population is relatively small, with the exceptions of South Wales and parts of Central Scotland.

The following table, expressed in round numbers, allows some interesting comparisons to be drawn.

	English Lowland	Atlantic Margins	British Isles.
Population	37,000,000	12,000,000	49,000,000
Area in square miles	40,000	62,000	102,000
Average density per square mile	925	195	480

Moreover, the economic and social developments of recent times have told against the ways of life in the greater part of these northern and western parts of the British Isles, and migration has caused a marked decline in the number of their inhabitants.

Relations between the Regions.—The characteristics described as common to the Atlantic Margins stand in marked contrast with those of the English Lowland, as they were reviewed in Chapter X of this book, and in the succeeding volume, which will deal with the Continent of Europe, it will be shown that the regions across the Narrow Seas on either side of the Strait of Dover resemble the English Lowland in many respects. The similarity is so marked that, although the shallow waters have invaded the continental area and isolated the English Lowland from the neighbouring continental sub-regions, it may be joined with them to form one minor region

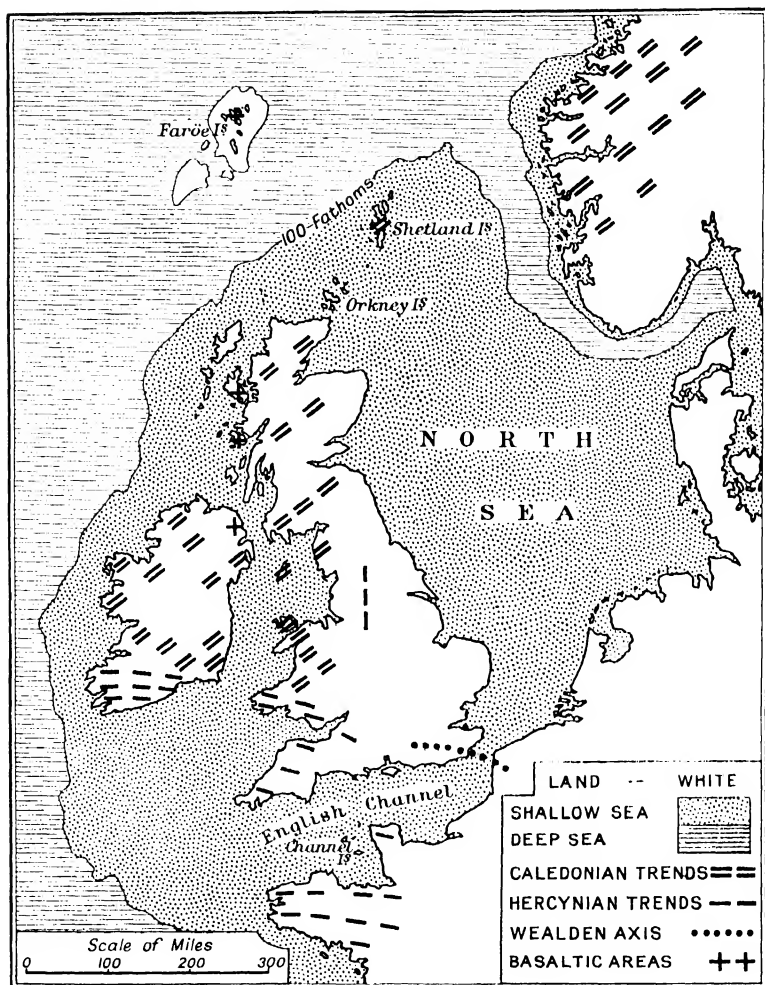


FIG. 58.—THE STRUCTURAL RELATIONS OF BRITAIN TO THE CONTINENT.

Note that four basaltic areas are shown in a north-south line, viz. the Farøe Islands, Skye, Mull and the Antrim Plateau.

to which the name "Mid-Temperate Lowlands" of Europe may be applied.

In contrast, the Atlantic Margins of Britain are markedly unlike these continental lowlands, and indeed it will be shown in the next volume that the Scottish Highlands have resem-

blances with South-western Norway, while Southern Ireland and the Devonian Peninsula have likenesses to Brittany and even to North-western Spain. This is the case to such a degree that the Atlantic Margins of Britain may be joined with the similar areas in Norway, France and Spain to constitute another minor region—the “ West-Temperate Margins ” of Europe.

Thus the British Isles form part of two distinct minor regions. Yet they both share, though to differing degrees, the general climatic conditions due to their world-position in the belt of westerly winds, and they are both situated on the western side of the great land-mass of Eurasia ; consequently, they are both comprised in the major region of “ Temperate Europe.”

Therefore marked as the contrasts are between, let us say, the London Basin in England, the Central Plain of Ireland and the North-western Highlands of Scotland, they all form part of the same “ Temperate Europe ” major region of the world, and the British Isles have more uniformity than some of the other larger countries of Europe.

Moreover, it must be clearly realized that the various regions, small and great, which constitute the British Isles are closely related to one another by their propinquity, and in many ways have important influences upon one another. The lines drawn upon the regional maps in this book indicate the approximate boundaries of areas of different characteristics, but they must not be taken as separating regions, in the sense that they mark the limits of the activities of the regions. On the contrary, the more contrasted the areas, the more complementary they may be, and the more marked may be their mutual influences.

Instances of such complementary interaction have already been given. In connexion with the physical geography, for example, it may be observed that the existence of the Atlantic Uplands on the weather-side of Britain tends to reduce the moistness and the equability of the English Lowland which lies on the lee-side. Again, where uplands and lowlands adjoin, rivers bring water from the former to the latter, and have even built up small alluvial regions from material derived from the higher parts of their basins.

In connexion with the human geography, it may be pointed out that man has increased the number and the variety of such inter-relationships. His aqueducts supplement the natural transfer of the water supply ; in his agriculture he may mix the

soils of adjoining areas ; in his pastoral work he may organize the migration of animals even from distant regions ; his manufactures often necessitate the collection of materials from various sources, and his commerce is essentially the interchange of products and therefore links up the work of the people of contrasting regions.

Indeed, since people commonly desire to take advantage of the resources of different types of country, human settlements, whether small or great, are frequently situated in marginal positions and at convenient points of entry to geographical regions. Further, administrative and political areas, such as parishes, counties and states, which may be considered as "human regions," commonly include parts of two or more "physical regions," precisely because the resources and opportunities of these supplement one another.

As man's activities increase, the links connecting the various constituent areas in human regions become stronger. Hence even political geography, which considers states as the special object of its study, cannot ignore the physical regions, but on the contrary must regard them as the foundation of the resources and needs of the political units. In short, the study of regions, from whatever point of view it is undertaken, must take account both of their internal characteristics and functioning, and also of their mutual relationships.

Thus the British Isles must be considered as a whole and also as a part of the European continent. As the map in Fig. 58 shows, these islands are simply the higher portions of the great continental platform, partly covered by shallow waters, from which emerge all the lands of Western Europe. The brief study of the peoples of Britain, which follows in the next section, shows how they have derived from the same stocks, and inherited the same cultures, as the peoples of the adjoining continent.

The Peoples of Britain.—The population of these islands is composed of individuals differing considerably from one another, and exhibiting a number of physical types, because they are descended from several racial stocks. Anthropologists are still examining the types and trying to disentangle the origins, but there has been much intermingling of the successive invaders and clear-cut conclusions are difficult to establish. It is, however, obvious that everywhere the peoples are of mixed characteristics

and descent, and none of the regions hitherto discussed is characterized by a population of one type. Although in some of these regions a particular language is commonly spoken, as was noted in preceding chapters, the use of the common language is no evidence of a similarity in the physical appearance of the people or of their common descent ; alien languages have often been imposed by invaders, and groups of people may change their speech, just as they may change their occupations and ways of life.

To give a consecutive account of the invasions and settlement of Britain by successive peoples, if the state of our knowledge allowed this to be done, would be the task of history ; the geographer's business is to state and, as far as possible, to explain the distribution of the types of people comprising the present population of the country. To further this end, however, it is convenient to adopt a simplified chronological arrangement, and to indicate in order of their appearance in this country the main racial stocks, referring also to particular areas in which their descendants now appear to be specially well represented.

The first-comers of whom there is fairly definite knowledge are probably the most important, from the point of view of their effect on the racial, i.e. physical, characteristics of the present-day inhabitants. They came as Neolithic stone-workers, after the Ice Age, but nevertheless thousands of years ago. They were more akin to the "Mediterranean" than to the "Alpine" or "Northern" group of European peoples, and migrated along the coasts of Spain and western France to the west of Britain ; they were generally rather dark in the colour of hair and eyes, in some instances rather short in stature, and with skulls relatively long in proportion to the breadth. These general characteristics are still common to the people of large parts of Britain, though in the course of many generations gradual evolution may have somewhat modified them in the British environment, and in particular individuals some of the characteristics have been displaced by mingling with later settlers. Of their language nothing certain is known.

At their low stage of cultural development, these long-skulled Neolithic peoples found the lowlands, then often swampy or forest-covered, difficult to utilize, and preferred drier and more open country. Consequently, they settled on such lands as the coasts and lower hill country in the northern and western Uplands

and the Downs of southern England. In the course of time, people learnt how to drain and clear the more fertile lowlands, and the descendants of these early comers spread out over most of the country ; the later invaders, however, did much of the work of reclamation and settled in such considerable numbers in the productive English Lowland, that the traces of the "Mediterranean" peoples are less clearly seen here than elsewhere. The first-comers are therefore now represented with least modification in such places as the valleys of the Scottish Highlands, the Uplands of Scotland, Wales and Ireland, the moors of the Devonian Peninsula, and even in parts of the Fenlands and parts of the chalk tracts of England.

Somewhere about 4,000 years ago came another, and markedly different, group of peoples to Britain. They were broad-heads, whose skulls were not quite as long in comparison with the breadth, and they were more akin to the "Alpine" race of Europe. They came from Central Europe and entered Britain from the south-east, settling in the more easily habitable parts of the lowlands of England and Scotland. They are sometimes called "Beaker" people because of the shape of the pottery they used, and they belonged to the Bronze Age of culture. Possibly, but not certainly, it was these people who introduced the first of the Celtic languages to Britain. The Celtic languages are classified into two groups : (i) Gaelic, which arrived first and includes Irish or Erse, Scottish and Manx, and (ii) Cymric, which came later and includes Welsh, the old Cornish language and Breton.

If the first broad-heads brought the first Gaelic languages, it does not at all follow that the present Gaelic-speaking peoples are their descendants. The languages may have spread westward to the earlier inhabitants, and many centuries after, they were probably adopted by settlers of still different races. In the main, the Gaelic languages are to-day spoken by people descended from the Mediterranean stocks, and Alpine characteristics are found to a relatively slight extent, mostly in small areas scattered along the western coasts of the British Isles.

The Cymric, or Brythonic, languages seem to have been introduced by people who had advanced to the Iron Age of culture, and who entered Britain during the centuries just preceding the Roman occupation. These people appear to have been rather long-headed, and in regard to stature and

colouration were intermediate between the rather short and dark "Alpine" and the tall and fair "Northern" races. They occupied the south-east of Britain more effectively than the earlier Celtic-speakers had done, though again there is little correspondence between the present Cymric-speakers and the people who show the physical characteristics of those who introduced the language. The speech spread to the west of Great Britain, but it has there been handed down by Welsh of very mixed ancestry, while it has been entirely displaced in the English Lowland, notwithstanding the fact that here there are marked traces of the continuance of the stock of the original Cymric immigrants.

The Roman occupation had little direct effect upon the composition of the population of Britain, but after the withdrawal of the legions the country lay open to waves of migrating peoples from across the North Sea. The first of these were generally intermediate between the Alpine and Northern types, and brought with them the Teutonic speech which developed into the English language. These Anglo-Saxons and Jutes settled in the southern and eastern parts of the English Lowland, and either displaced or mingled with the existing population in most districts; consequently descendants of the earlier peoples can be clearly distinguished only in the least attractive or least accessible places. Everywhere in the east, however, the speech was changed.

From the Trent northwards, the river valleys and the coastal harbours were entered by the Danes and the Scandinavians, the latter being the true North-men, fair-haired and tall, and with long skulls. These folk settled especially on the lowlands on the east side of Great Britain, in some parts almost completely displacing their predecessors, so that from Lincolnshire to Caithness the present population is predominantly of the Northern type. In the valleys of the Uplands and Highlands behind the coastal belt, however, a larger proportion of the people have the darker colouration and lower stature characteristic of the Mediterranean race.

The Northmen worked their way also round the north of Scotland; they occupied much of the coasts and islands of Western Scotland, and raided the lands southward as far as the east of Ireland, Wales and the Severn estuary. Throughout these regions there are evidences of their racial traits, but they

did not displace the earlier inhabitants nor was their language widely imposed. The Celtic languages persisted over a great part of this region, giving way much later and very slowly to the advance of English from the eastern side of Britain.

The Norman invasion, like the Roman, probably brought relatively little change from the racial point of view, though its effect on the language and other cultural characteristics was great, and later immigrants, such as those from the Low Countries, the Huguenots and the Jews, had mainly economic influences on the life of the country.

In recent centuries, emigration has been considerable. Because of economic pressure, large numbers of people from the poorer lands of the Atlantic Margins have gone overseas, especially to the British Dominions and to the United States; also it seems probable that the spirit of adventure has moved many people of the Northern stocks to migrate westwards as their forefathers had done.

Movements within Britain, too, must be brought into a racial survey, and among these, migrations to and from Ireland and the west of Great Britain have had important consequences. Also in recent times the relative poverty of the Atlantic Margins has been an important factor in leading to considerable migration into the English Lowland, especially to the coalfields in which there was a very great increase of population in connexion with the Industrial Revolution. Anthropologists have brought forward evidence that the darker peoples of the Mediterranean type seem better able to withstand the conditions of life in the mining and industrial communities than the fairer people of the Northern type; if this is so, it would be a factor of relatively recent date, tending towards a predominance of the Mediterranean stocks even in the English Lowland, where the Northern occupation had been most effective.

The London region is populated by people of extraordinarily mixed ancestry and characteristics. Like other ports, especially Liverpool, it has an unusually large proportion of recent immigrants, and there are "foreign quarters" in several districts; moreover, the recent growth of manufacturing on the outskirts of the metropolis has led to an influx of workers from several of the Midland and Northern areas.

It is therefore clear that the racial origins and the physical characteristics of the population of Britain are extremely com-

plex. Equally complex, and far more subtle and elusive, are the mental traits of the people. It may be that the racial stocks have corresponding mental attributes, but no clear relationship can be demonstrated. Traditions which are connected with language and religion, with social and legal systems, and with economic conditions, are handed down among communities, quite apart from the racial origins of their members. It is impossible, however, to attempt here any examination of such varieties of tradition, beyond pointing out that, in the main, the sub-regions are associated with characteristic ways of life and perhaps even modes of thought. The Highlanders, for example, may be contrasted in several respects with the Lowlanders of Central Scotland; again, careful observers have pointed out the similarities among the people of the Central Uplands of Britain from the Pennines to the Scottish Uplands.

Moreover, a broad and significant contrast appears in this connexion between the English Lowland and the Atlantic Margins. In the case of the former, successive waves of invaders imposed their cultures upon their predecessors and the later comers succeeded in establishing a considerable amount of uniformity, for example as regards language, over the whole region. In the Atlantic Margins the immigrants, however powerful they may have been at the time and place of their conquests, were to a large extent absorbed by the previous occupants of the regions, and in consequence earlier racial stocks, languages and traditions have survived.

Apart from characteristics of the population which are derived from the past, contrasts depending on present conditions may be observed and a broad distinction may be made between dwellers in the urban districts and those in rural areas. In the country a shepherd or farmer is in close touch with nature and very dependent upon natural conditions, while by comparison the town-dweller lives in a man-made world; consequently the countryman (like the sailor) is much more "weather-wise" than the townsman.

The workers on the land have to obtain their living directly from nature, and may be conscious of a real "struggle for existence," in which their skill and industry are pitted against natural forces; those engaged in trade and industry are only indirectly dependent upon nature, and their fortunes are more largely determined by the economic organization of mankind.

Derangements of the mechanism of banking and finance, or the alternate "booms" and "slumps" in the production of commodities, may bring suffering and sorrow to them, and often they feel that their struggle for existence is against their fellow-men in competing for work or trade.

As the shepherd and farmer live a more solitary life and the townsman is more gregarious, there is a common tendency for the youth of the countryside, who want the attractions of company and the diversions offered by the towns, to leave the rural quietude and seek work in urban communities. Yet this contrast is now weakening, since motor-buses take the dwellers in isolated farms or small villages into the neighbouring towns, and the wireless brings into their homes possibilities of wider contacts, education and entertainment. Nevertheless, it still remains true that the differences between rural and urban regions extend not only into the work, but also into the habits and the minds of their populations.

The influence of his environment upon man may be clearly seen on the western coasts of Britain, where the effort to wrest a living from a reluctant land, and the struggle with the winds and sea, constantly demand great exertions and endurance, and where the influence of isolation is most marked; such conditions must affect the character of the people. On the other hand, in the east of Britain nature is more kindly, and gives relative wealth and leisure to many, affording them opportunities for pursuing knowledge and cultivating the arts.

Geography has its roots in the dim past of the earth's history, but its flowering appears in the mental attributes of mankind.

APPENDIX I

GEOLOGICAL TABLE

Era.	Formations.	Earth Movements
Quaternary	Recent—Alluvium, Sand-dunes, etc. Valley Brick-earth and Gravel. Glacial Deposits. Clay with Flints.	
Tertiary	Pebble Gravels. East Anglian Crag. Bagshot Series. London Clay. Lower London Sands—Blackheath Beds, Woolwich and Reading Beds, Thanet Sands.	← Alpine
Secondary	Cretaceous—Chalk, Gault and Greensands, Wealden Clay and Sands. Jurassic—Upper Oolite (Kimmeridge Clay). Middle Oolite (Corallian Series and Oxford Clay). Lower Oolite. Lias—Upper, Middle, Lower. Trias—New Red. Permian—Magnesian Limestone, Red Marls and Sands.	
Palæozoic	Carboniferous—Coal Measures. Millstone Grit. Mountain Limestone (or Calciferous Sandstone). Devonian—Old Red. Lower Palæozoic—Silurian. Ordovician. Cambrian.	← Hercynian ← Caledonian
Archæan	Torridonian. Lewisian.	← More than one—but obscure.

APPENDIX II

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Many valuable articles published in *The Geographical Journal*, *Scottish Geographical Magazine*, *Geography* (formerly *The Geographical Teacher*), *Journal of the Manchester Geographical Society*, *Geographical Review* and *Economic Geography*. Among these articles, those by Dr. S. W. Wooldridge in the *Geographical Journal*, September 1931, in *Geography*, June 1932, and in *Antiquity*, September 1933, must be specially acknowledged.

The maps, on various scales, issued by the Ordnance Survey and the Geological Survey are indispensable for careful study, and those published by Bartholomew will be found useful. Current statistical information is to be obtained in the publications of the various Government Departments.

GLOSSARY AND INDEX TO REGIONAL TERMS

STOW.—The smallest unit-area of geographical study. A region of the first or lowest order, comprising a portion of the earth's surface which is (*a*) distinct from adjoining areas, and (*b*) so integrally related in its several parts that it cannot be divided without separating areas that must be examined together.

Examples : see pp. 4, 10, 12, 21, 25, 28, 29, 33, 34, 49, 52, 53, 54, 55, 57, 58, 60, 74, 108, 143, 171, 229.

FEATURES OF A STOW.—Areas comprising a stow, integrally related to one another though different in one or more characteristics.

Examples : pp. 9, 10, 11, 12, 28, 31-33, 74.

TRACT.—A region of the second order, composed of two or more stows which are (*a*) adjacent, and (*b*) closely related, to one another either in their characteristics or in their evolution.

Examples : pp. 4, 12, 18, 29, 48, 76, 77, 85, 88, 112, 120, 136, 141, 161, 162, 168, 170, 171, 179, 198, 221, 223, 224, 227, 229, 258.

SUB-REGION.—A region of the third order, composed of two or more adjacent and related tracts.

Examples : pp. 12, 171, 196, 211, 231, 233, 248, 267.

MINOR REGION.—A region of the fourth order, composed of two or more adjacent and related sub-regions.

Examples : pp. 12, 270, 271.

MAJOR REGION.—A region of the fifth and highest order, composed of two or more adjacent and related minor regions.

Examples : pp. 13, 272.

SIMPLE REGION, e.g. stow or tract.—A region which throughout its extent has had a common evolution and exhibits closely related characteristics.

COMPOSITE REGION, e.g. stow or tract.—A region which comprises areas intimately associated in situation but of contrasted characteristics, due either to the inclusion of different structural elements or to the elevation of portions into zones of different climatic conditions.

Examples : Composite stows, pp. 86-87.

Composite tracts, pp. 92, 94, 108, 111, 184, 228, 240, 248, 261.

Composite sub-regions, pp. 248, 267.

REGION-GROUP, e.g. stow-group (or tract-group).—An area composed of two or more stows (or tracts) which are closely related to one another in evolution and characteristics, but are not

sufficiently different from other adjacent areas to form independent units of the next higher order.

Examples : Stow-groups, pp. 49, 51, 52, 59, 79, 137.

Tract-groups, pp. 79, 166, 168, 170, 180, 190, 211, 226, 233, 260.

EXCLAVE.—A region which has characteristics similar to those of a region of higher order from which it is spatially separated.

Examples : pp. 52, 59, 95, 103, 128, 156, 211, 237, 247.

INTER-REGIONAL STOW.—A stow which separates regions of higher order and cannot be incorporated into any of them because of its distinct characteristics.

Examples : pp. 161, 201, 238.

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